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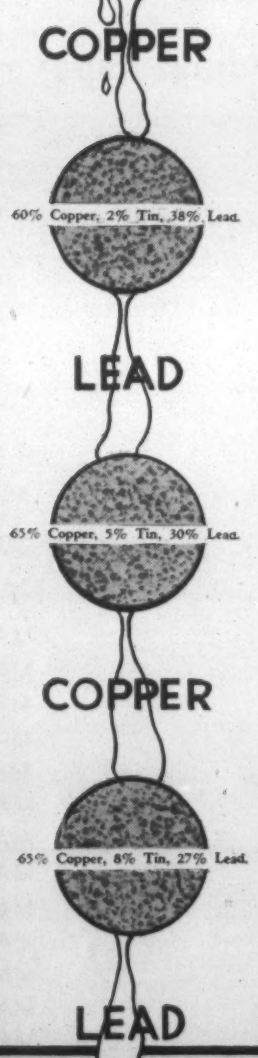

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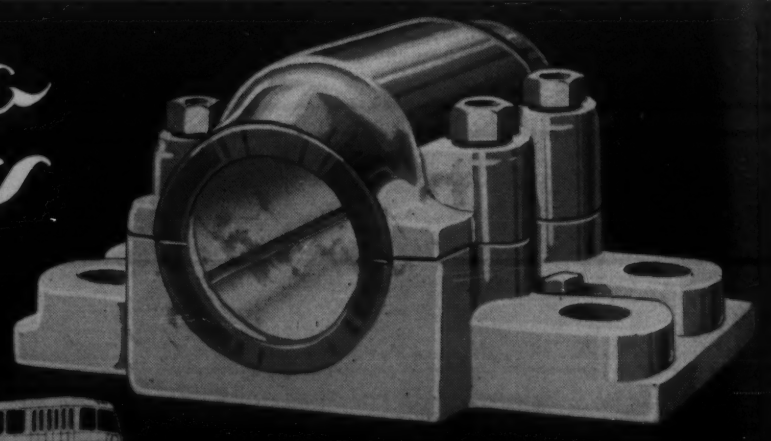

HIGHLIGHTS

by H. W. GILLETT

Data on Chromium Plating Tools

Dr. Blum (page MA 62 R 4) appraises a little pamphlet on chromium plating of gages, lathe tools, drills, etc., as useful and valuable.

Book on Hardness

Hardness and hardness testing now has a whole book to itself, one by O'Neill, a recognized authority on the subject (page MA 64 R 2).

What's in a Name?

We're used to Russian names ending in "off" or "ski" but Ananiasschwili and Gogo-beridse strike us as unusual. Anyhow, these authors pile up more evidence against "amorphous" metal (page MA 69 L 1).

Class Distinctions

If metals of one class, says Russell (page MA 69 R 1), react in mercury with metals of another class, compounds like $Sn_4Cu_{12}Zn_7Hg_{33}$ may be formed. What class name should be given to such offspring? They sound like mongrels to us.

Hardened Copper

By compressing copper powder under 15,000 atmospheres Trzebiatowski (page MA 69 R 3) gets metal of 190 Brinell, while the hardest cold worked massive copper we can find record of is around 130.

Prefers a Cr-Mo Steel

Hartner-Seberich (page MA 80 L 1) likes a Cr-Si-Al-Mo steel for cracking steel tubes better than 4 to 6% Cr-0.50% Mo (page MA 80 L 1).

Tombstones of Cast Iron

Osann (page MA 80 L 3) suggests replacing tombstones by cast iron ones. While this might help the foundry industry, we can't get much excited about a 1935 model tombstone. Besides, we plan to be cremated and to have our ashes dumped out somewhere around camp, so we're not even in the market for a cast iron urn.

Some Inspection Trip!

In an account of an inspection trip during the international foundry conference in Czechoslovakia, it appears that midway in the trip the delegates visited a shoe factory and at the end, the Pilsen brewery (page MA 81 L 2-3).

Novel (?) Way to Cut Cost of Steel

A chemical engineer (page MA 82 L 5) volunteers his guesses as to how, after spending 5 millions a year for ten years in development, it might be possible to cut steel production costs by 5 dollars a ton by "continuous counter-flow methods." And then again there might be some insurmountable problem that would be a stubborn missing link. Prophecy is easy in a case where the prophet isn't likely to be called upon to make good.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Salt and Soda

Iwase and Ota (page MA 54 R 4) claim that ordinary salt and soda make as good an energizer for carburizing as barium carbonate.

Keep Your Powder, and Your Cores, Dry

We all know that cores become weak if they are allowed to stay in a green sand mold too long before pouring, or are kept in a damp place. Sefing and Surls (page MA 48 L 2) find that the deterioration due to dampness is permanent and strength is not restored by re-drying.

Welding for Making Bridges Stronger

Six main advantages of strengthening bridges by means of welding are set forth by Otto Bondy (page MA 59 L 1). A comparison between standard British and German rules for the application of welding is made.

Factors in Processing Chill Rolls

A German author, Gustav Krebs (page MA 48 R 8), discusses various points which should be observed in processing chill rolls. He offers 21 different conclusions. Of interest is his observation that "the larger the cooling velocity, the lower the nickel content required to attain decomposition," and "finer structure and higher hardness are attained by proper casting temperature."

Overcoming Difficulties in Hardening Cr-Steels

A solution of some of the difficulties in hardening chromium-bearing steels without soft spots is offered by B. Kjerrman (page MA 54 R 1). Relation of flow of gas and air on a program is recommended. Uniform hardening of large bearings is claimed assured.

Wear a Diver's Helmet, Not a Welder's

Schmidt (page MA 60 R 10) advocates arc welding under water. That's one way of keeping air away from the weld.

Covered Electrodes Make Strongest Arc Welds

Covered electrodes give the strongest welds in arc welding for bridge construction (page MA 61 L 6).

Fusion Welding of Stainless Steels

German experience in the fusion welding of rust and heat-resistant steels is recounted by Hans Melhardt (page MA 58 R 10). He discusses plain chromium and Cr-Ni steels. The contents of the steel as to Cr and C must be known when welding these steels. The Cr-Ni steels are austenitic and when they are welded, carbides segregate at the grain boundaries with the result that intercrystalline corrosion will take place if the steel is not submitted to heat treatment by heating to 1100°C. and subsequent quenching.

Progress in Brazing

A French author recounts (page MA 58 R 2) previous objections to brazing methods and cites two improvements, (1) addition of other metals with the discovery of new alloys which give almost no fumes of zinc, and (2) a new white brazing alloy obtained by adding nickel to the brass usually used. This shows good "wetting" properties and is suitable for repairing or manufacturing.

New Way to Clean Metals

No acids are used in a new method of cleaning metals for electroplating which is claimed to insure an absolutely clean surface. This eliminates the problem of disposing of waste acid. Other advantages are cited (page MA 62 L 8).

New Cd-Ag-Cu Bearing Alloys

New bearing alloys containing Cd, Ag, and Cu have been developed (page MA 71 L 6). These are described as a new type of high load capacity bearing material. Special properties include low manufacturing cost, less likelihood to score soft shafts, greater resistance to corrosion and so on.

Mexicans Use Metal Spraying

All meter boxes of a large Mexican utility are to be lined with zinc by metal spraying. Other applications of metal spraying are recounted (page MA 63 L 7).

Test Bars for Steel Castings

A French foundryman recommends a standard test specimen for cast steel —a plate cast on edge and gated on one end above the center line, the lower half to be used for testing. This gave the best physical results (page MA 64 R 9).

Low Melting Point Brass for Die Casting

The best brass alloy for die casting is a 60% Cu-40% Zn composition says Freeman (page MA 72 L 9). It has the lowest melting point of the commercial brasses so that the available steel dies will stand up under operation.

CHARPY IMPACT STRENGTH

. . . 15-20 Ft.-Lbs.?

Impact strength figures for the Zamak Die Casting Alloys have been published many times; the A. S. T. M. and the S. A. E. have specified the minimum impact strength of their recommended ZINC Die Casting Alloys — as measured on a standard 1/4" x 1/4" die cast test bar. We have all used these figures in a comparative manner. But many have wondered just how the strength of commercial die castings compared to these figures.

To answer this question the Research Division of The New Jersey Zinc Company has conducted some rather extensive tests. These tests were carried out on 520 specimens machined from 77 commercial ZINC Alloy Die Castings. (Ranging in weight from 3 oz. to 13 1/2 lbs., and in length from 3 in. to 49 in.) Due to varying wall sections in these castings the test bars could not all be the standard 1/4" x 1/4" size. In order to cover the widest range of commercial conditions, specimen sizes were cut: 1/4" x 1/4", 1/2" x 1/8", 1/2" x 0.080" and 1/8" x 1/8". Dies were also made and specimens die cast to these sizes.

Concerning the results on the 1/4" x 1/4" specimens which are typical of the results on the other sizes, the investigators found*:

"The peak of the (Frequency) curve falls between 10 *and* 20 *ft.-lb. The average, 18.75 ft.-lb., agrees well with the authors' average test bar data of* 19.00 *ft.-lb. for alloy No. XXI* (A. S. T. M.) *and* 20.00 *ft.-lb. for alloy No. XXIII* (A. S. T. M.)

"Attention is called to the relatively large number of specimens which exceeded 35 ft.-lb. in strength. These were all cut from a group of automobile windshield stanchions of heavy section weighing about 10 lbs. each. It would seem that for a depth of 1/4", at least, large-section castings can be at least as strong as test bars.

"It is apparent from the data that so far as impact strength is concerned *a close agreement exists between the properties of die cast test bars and of sections cut from the surface of commercial die castings.*"

We have a small stock of this complete report and will gladly fill requests for single copies as long as our supply lasts. These copies will, of course, be sent without obligation to you.

*** From the copyrighted Proceedings of the American Society for Testing Materials. "The Impact Strength of Commercial Zinc Alloy Die Castings," by E. A. Anderson and G. L. Werley.**

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Editorial Comment

Clinics

WHEN A MAN IS SICK, and knows it, he goes to his family physician who either himself diagnoses and prescribes or sends the patient to a specialist who can do so. Some people don't wait to be sick, but go to a clinic for a general checking over every so often to find out if they are O. K. or whether there is something wrong, the effect of which is so gradually shown that the patient may not be aware that he is not in the best shape.

A manufacturing plant that is having excessive losses in production, or that cannot sell its product, knows that it is sick and either seeks a remedy itself, or the bankers take it over and put in some one to run it who will make, or get, a diagnosis and prescription. But there are many plants which are in poor health because of use of obsolete equipment, antiquated methods and materials that should have been superseded by better ones; but their rising costs and drooping sales come on so slowly that the management doesn't realize that things are not as they should be.

There seems to be nothing in the business world quite analogous to the clinic. True, there are efficiency engineers who may be, and sometimes are, called in on suspicion that there may be something wrong that an outsider can detect better than the insiders. But, in fact, there may be many new and desirable methods, apparatus and materials that the efficiency engineer doesn't know about, even though, to those concerned with the development of such things, utility for the case in hand would be obvious, if they only knew about the case.

How then, does information as to new things percolate into the corners where it should be utilized? Major developments, directly in line with the chief operations of the business, are likely to come pretty directly to the attention of those who could utilize them, through salesmen, trade and technical journals, conventions, and so on. But how about the apparently minor things, such as the metallurgical needs of the so-called non-metallurgical industries, where the casual observer would hardly realize the vital part metal tools, containers and so on play in the processes? We have been able to arrange for discussions in METALS & ALLOYS of this topic by representatives of some of the industries that are already quite conscious of their dependence on better metals. But we feel sure that there are many industries and plants not yet conscious of this, and a long way from the point where they will add a metallurgist to their staff; plants which buy from some jobber what they think they should use, i. e., what they have always used, whose executives do not see technical journals outside their own particular line, and who are not visited by salesmen of the specialties they could utilize.

With the spreading of the technical sales effort of groups like the International Nickel Company, as a notable example, to the small individual user, and the flood of house organs that will be sent on suspicion that the recipient might be interested, this situation is being overcome in respect to some materials and equipment. Information on methods and processes that will require them may be passed on as a way to sell materials and equipment, but only those facts which directly involved what the informant has to sell, are thus supplied.

Most any up-to-date metallurgical consultant could, off-hand, suggest improvements to lots of firms who are still using what they did ten years ago, but he is not likely to be called in, nor is it at all obvious to the consultant that there is an opportunity for him. Similarly, the purely metallurgical plant may be up-to-date in all strictly metallurgical lines and very far behind in regard to other types of materials used in its processes.

Sometimes a plant, groping for improvements, writes the Bureau of Standards or some other government agency for suggestions, and may thus either get direct information, if the plant describes its troubles clearly enough, or be guided to some expert consultant or research laboratory fitted to pass on the matter, who will make the personal visit generally necessary for a diagnosis. But there is no easy way by which any outside agency can interrogate the plant as to what it needs to know. The clinic doesn't yet go to the patient, the patient has to come to the clinic.

We don't believe that it would be an answer to have some government agency like the Farm Bureau poking into manufacturing plants to make suggestions. The plant, or its trade association, should take the initiative. Perhaps if there were more organizations analogous to the medical clinics, or more knowledge of the existence of the consulting and research organizations that are already somewhat analogous to them, the difficulty would adjust itself. At any rate, we feel sure that if every organization that needs it could be given the benefit of the knowledge that science and technology have accumulated, or are ready to accumulate, to answer a new problem once that problem is clearly stated, production costs would go down, and new or more saleable products would appear, in sufficient degree to make quite an impression on the depression.

As a notable example of the passing over of rather vital problems to specialists, we may cite the automotive industry. The role played by the suppliers of parts like carburetors, bearings, valves, spark plugs,

(Continued on page 38)

An Index to 19,612 Metallurgical Articles

About the CUMULATIVE INDEX for 1932, 1933 and 1934

Early in 1935 we will publish the second volume of the Cumulative Index of Metals & Alloys Current Metallurgical Abstracts. This index will cover the abstracts which appeared from January 1932 to December 1934. It will be the same page size as Metals & Alloys, cloth bound, approximately 150 pages, and will cover 19,612 abstracts of articles and books.

The price of this index is $10.00. As we will print only enough copies to take care of the orders we receive before March 1st, 1935, we urge you to

Place an order for your copy at once.

John A. Mathews

AN APPRECIATION

By Albert Sauveur

SIMPLICITY, modesty, sincerity, friendliness and generosity are some of the virtues which endeared Dr. John A. Mathews to his friends. Added to these Christian attributes was a mind of rare quality, a clear and broad vision, a dislike of sham and of dogmatism, a directness and scientific honesty, which gave to his writings an importance and significance universally recognized.

How many of us, young and old, turned to him when in need of assistance by way of sound advice, encouragement or actual cooperation, never to return empty-handed; always benefited by his ready response to our appeals, so sympathetic, so unselfish and so wise. To the younger college men standing at the threshold of their careers, who had the good fortune of personal contacts with him, he was a tower of strength and an inspiration. He would guard them against the deadly sin of conceit and pretentiousness and instil into them becoming modesty and earnestness of purpose.

Men of Dr. Mathews' stature are rare in any walk of life and their deaths create in the world around them a sense of irreparable loss.

Photo by Blank-Stoller, Inc.

It will suffice in this brief and inadequate appreciation to recall some of the salient facts in Dr. Mathews' professional life. He was at the time of his death vice-president and director of research of the Crucible Steel Company of America, a position he had held since 1923. He had been previously metallurgist and assistant manager of the Sanderson Works of the same company, from 1902 to 1908, general manager of the Halcomb Steel Company, Syracuse, New York, from 1908 to 1915 and president of that company from 1918 to 1923.

He served as Assay Commissioner in 1900, 1920 and 1911, having been appointed to that office successively by Presidents McKinley, Roosevelt and Taft.

He served during the war on several important commissions and was chairman of the Aircraft Engine Forgings Commission.

Dr. Mathews obtained his B.S. degree from Washington and Jefferson College in 1893 and an M.S. degree three years later. In 1902, the same institution awarded to him an honorary degree of Doctor of Science. In 1895, he received an M.S. degree from Columbia University, and in 1898 the Ph.D. degree from that University. From 1900 to 1902, inclusive, he was the holder of the Barnard Fellowship for the Encouragement of Scientific Research. He spent the year 1900-01 at the Royal School of Mines (London) under the late and illustrious metallurgist Sir William Roberts-Austen. Dr. Mathews was the first recipient in 1902 of the "Andrew Carnegie Gold Medal for Research" of the Iron and Steel Institute of Great Britain. In 1928, he was awarded the Robert W. Hunt gold medal of the American Institute of Mining and Metallurgical Engineers. In 1925, he delivered the second Henry Marion Howe memorial lecture before that Institute.

Dr. Mathews' activities were not confined to the practice of his profession, for he was a public spirited citizen giving freely of his time and thought to the demands of the community where he lived. Indeed, he held in high regard one's civic duties. He had been president of the Syracuse (New York) Chamber of Commerce, a director of the First National Bank of that city and of other banking institutions. His reports on "Municipal Ownership of Lighting Plants" and on "Smoke Abatement" commanded wide attention.

FOR the third time, METALS & ALLOYS has lost a member of its Editorial Advisory Board, Dr. John A. Mathews having passed on, along with L. W. Spring and W. H. Bassett.

Dr. Mathews was active to the last. Indeed, he spent much time during an apparent recuperation from an illness only two or three weeks before his death in going over and making his usual helpful comments on the draft of a monograph on Iron-Carbon which we are helping to prepare in the series being put out by the Alloys of Iron Committee, of which Dr. Mathews was a member. When we told him that he should have read detective stories rather than metallurgy during convalescence, he replied that he got more pleasure out of reading metallurgy than anything else.

Last fall, we tried to persuade him to jot down some of his metallurgical reminiscences for publication in METALS & ALLOYS; he agreed that he had seen many interesting developments on which comment would be of interest, but said that he was still too busy with developments for the future to spend time on the past.

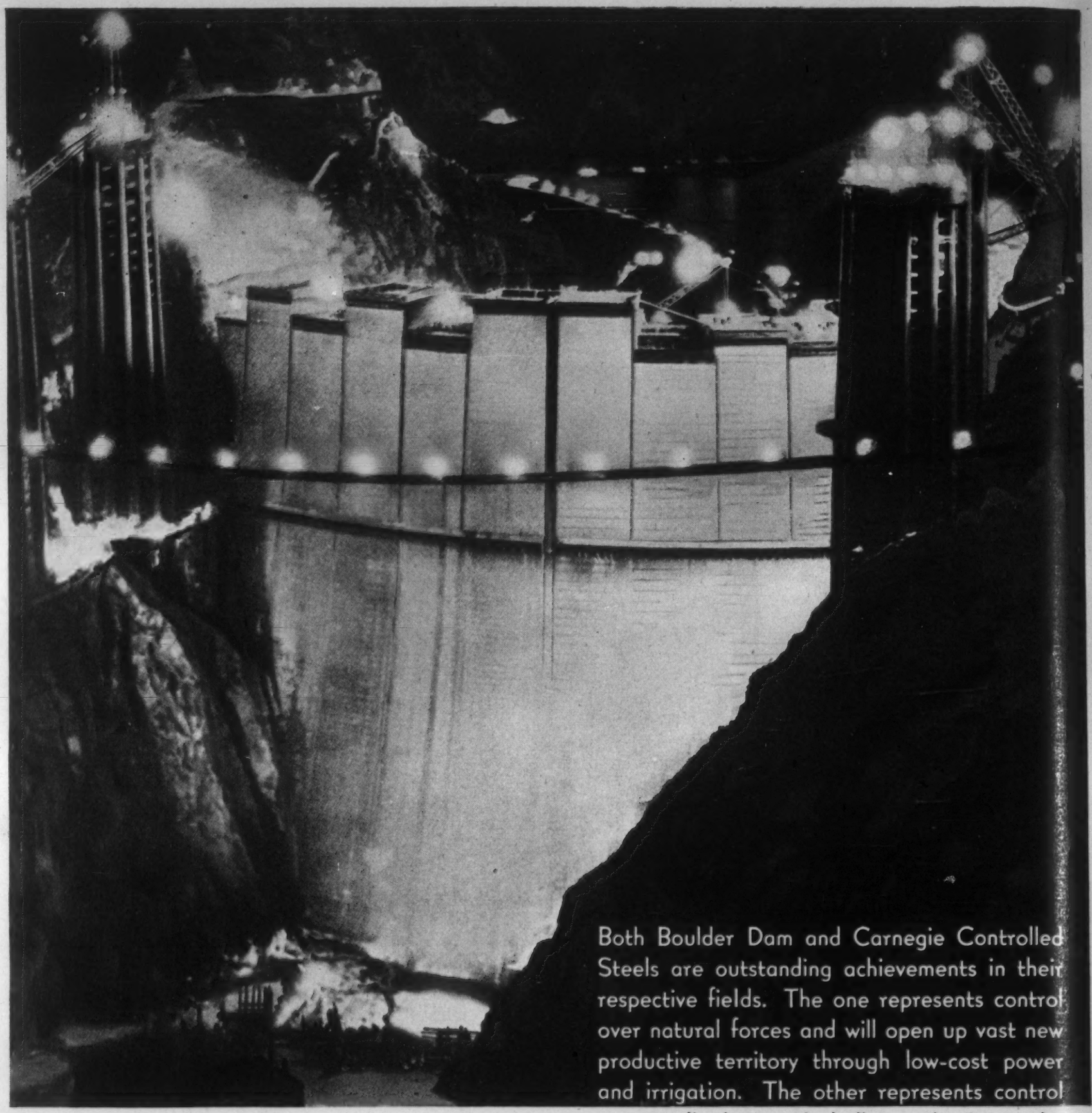
Not only did he see many developments, but he made many. "All of which I saw, much of which I was," could well have been quoted by him in regard to electric steel melting, high-speed steel, retained austenite, magnet steels and many other fields in which he did pioneer work. He was one of the most influential exponents of "quality steels."

With all his executive duties, he kept up on the fine points of steel metallurgy, and was never too busy to help any worthy effort for the advancement of metallurgy, or to give from his vast store of experience to younger metallurgists.

He was extremely approachable, and like Spring and Bassett, contributed much to the breadth of view of the many technical committees on which he served.

Dr. Mathews was a big man physically, with a mind and a heart as big as his body.

American metallurgy has lost another of its elder statesmen, and METALS & ALLOYS has lost an adviser whose sound comment helped to settle many an editorial plan and whose technical criticism improved many an article. We mourn him not only as a mentor, but as a friend.—H. W. G.



Both Boulder Dam and Carnegie Controlled Steels are outstanding achievements in their respective fields. The one represents control over natural forces and will open up vast new productive territory through low-cost power and irrigation. The other represents control over quality factors, including grain size, in the manufacture of open hearth carbon steels for forging and heat-treatment. Long sought and now finally accomplished, this control opens up a vastly widened field of usefulness for these comparatively inexpensive steels. Have you studied this truly important development in relation to your own steel requirements? If not, let's discuss it at once.

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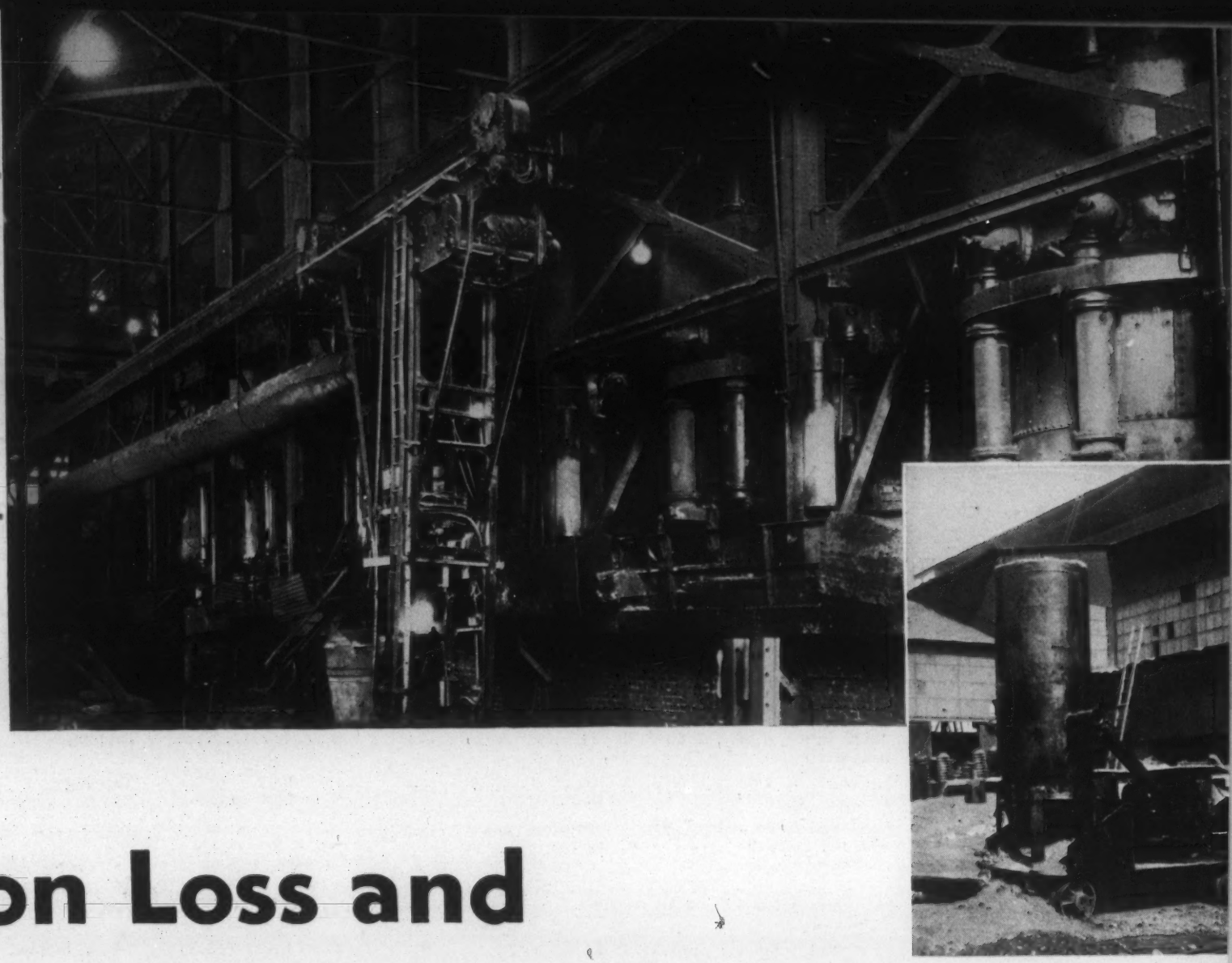


Row of Seven Cupolas at the Plant of the American Cast Iron Pipe Co., Birmingham, Ala.

A 22-Inch Diameter Portable Cupola, Used for Experimental and Special Work, by the American Cast Iron Pipe Co.

Carbon Loss and Pick-Up in the Cupola

A Correlated Abstract by

H. H. Langebeck*

Translated by James T. MacKenzie**

IT IS A WELL known fact that the cupola process is not a simple melting process for changing solid iron into molten iron. There also occur in the process quite complicated metallurgical phenomena, of which that of the carbon changes is the one of immediate interest.

In discussing this subject, we must distinguish between charges which have a high carbon content, such as pig iron and cast scrap, and those of low carbon content, as with large percentages of steel scrap. With high carbon charges we have to deal with a loss of carbon, while with low carbon charges we have to deal with an increase. So far, there seems to be unanimous agreement among the different investigators. Differences of opinion appear first when we come to calculate the degree of carburization or decarburization, and to state exactly the melting conditions necessary for the different changes.

If we compare the corresponding results of the different investigators in this field, as is shown in Table I, we could easily come to the premature conclusion that there is no relation between the carbon content of the charge and that of the melt and could, as Osann actually has done, say that the carbon content of the steel additions always came to the constant value 2.7%. Osann's dictum has a certain practical value for routine operations but it suffices in no wise to give the right value for all of the different melting conditions.

There is actually a relation between the amount of steel scrap in the charge and the carbon of melt, but there is no simple proportionality between the two. The maximum of carburization is determined by the eutectic concentration of 4.3%, since above these values all of the extra carbon dissolved in the molten iron will be given off as kish in the freezing process. However, this eutectic concentration is seldom reached in normal cupola operation. The reason is twofold: 1. Equilibrium is not obtainable in the short time available for the reactions of this heterogeneous system consisting of so many components, and all the phases: solid, liquid, and gaseous. 2. The eutectic point is driven to the left by many of the metalloids, especially silicon, phosphorus and sulphur. According to the investigation of Emmel,[5] made in practical furnace operation, 0.8% silicon lowers the carbon pickup by 0.1%. Klingenstein[4] finds somewhat lower results, but those of Sipp and Tobias[11] are very close to those of Emmel. Sipp and Tobias found no influence of phosphorus on the carburization process. This is, however, in direct contradiction to the investigations of MacKenzie on this

* Consulting metallurgist, Aliquippa, Pa.
** Chief metallurgist, American Cast Iron Pipe Co., Birmingham, Ala.

subject, according to whom phosphorus additions of 3.5% in the charge reduced the carbon of the melt from approximately 4.0 to 3.0%.

Piwowarsky and Schichtel[13] show on valid physico-chemical grounds that in addition to phosphorus and silicon, nickel also pushes the eutectic point to the left. Williams and Sims[14] show also that sulphur works in present knowledge is shown by the results of Piwowarsky, Langebeck and Nipper.[10] These results are shown in curves 3 and 4. All of these curves show clearly that there is a relationship between the carbon content of the charge and that of the melt, but that no simple proportionality can be stated. While the low carbon charges try to come to the eutectic concentration, and

Table 1

Ref. No.	Author	Cupola Mixture	Carbon in: Mixture	Carbon in: Melt	Furnace Data: Diam. in.	Furnace Data: Bed in.	Furnace Data: Distance from Tuyere Level to Bottom in.	Melting Conditions: Blast Pressure	Melting Conditions: Coke Ratio	Discharge of Metal	Remarks
1	Wüst	7-20% steel addition 100% pig	around 3.0% 3.4%	3.53 3.33–3.2	32	..	..	....	.....	a) Tapping b) Continuous flow into forehearth	a) Considerable C-increase in spite of steel scrap addition b) Decarburization due to shortest coke contact
2	Anon.	100% soft steel scrap	below 0.2	2.25	..	..	..	....	.....	.....	Refutes any proportionality between C of mixture and C of melt
3	Field	100% soft steel scrap	0.28	2.80–2.90	24	..	..	12	.....	Tapping	Studies mechanism of carburization
4	Klingenstein ..	low steel add.	3.08	3.30–3.48	med. size	..	..	....	1:12 (8%) 1:10 (10%)	Tapping	Studies influence of Si on carburization
5	Emmel	50% steel 50% pig	around 2.0	2.7–2.9	med. size	..	..	....	.....	.....	Keeps all melting data secret; these are considered of great importance regarding carbon
6	Greenhow	98% springs +rail ends	0.6–0.8	2.64	36	45	..	10	1:7 (14%)	Tapping	Aims at making high test iron
7	MacPherran ..	⅔ springs ⅓ rails	0.6–0.8	2.40–3.10	54	23	19	8	1:7.5 (13.5)	Short tapping	Aims at making high test iron
8	Olson	20% steel 50% steel	2.77 1.48	3.1 2.8	42	30	12	7–9	.....	Cont. flow into a 2000 lb. forehearth	Finds that carbon control is readily possible
9	MacKenzie	100% steel 100% pig	0.40 3.7–4.1	1.8–4.3 3.4–3.2	18	34	17	6–10	1:4 (25%)	Tapping	Studies cokes with various ash contents and carbon equilibrium in the cupola
10	Piwowarsky, Langebeck & Nipper	100% steel 75% steel 50% steel 25% steel 100% pig	0.13 0.90 1.80 2.70 3.55	1.6–1.9 2.25 2.4–2.6 2.8 3.3	15	25	20 (5 in one case)	6–10	1:6.6 (15%)	Cont. flow into forehearth	Study influence of amount of air, of coke ratio and various melting conditions
11	Sipp & Tobias.	....	1.5 up to 2.9	2.5 3.1	36	..	20	....	1:9 (11%)	Tapping	Find no influence of P and Mn on C pick-up. Confirm Piwowarsky's and coworkers' findings also for normal size furnace

the same direction. These authors found that in desulphurizing electric furnace baths from 0.75 to 0.05 the carbon continuously increased from 2.5 to 4.0%. Fletcher[15] assembles all of these factors in one formula, which reads: "Carbon = 4.3 — 0.286 Si — 0.387 P + 0.048 (Mn — 1.8 S)." According to this formula a normal cast iron would have its maximum content of carbon in the neighborhood of 3.5, but under normal melting conditions (normal quality of coke, amount of coke, and tapping time) we find the carbon content somewhat lower, viz.: around 3.3%. Charges with more than 3.3% carbon, therefore, generally lose, while those under 3.3% gain. It must be understood, however, that this value has no absolute validity, but is simply a figure to use for general application.

In order to show this clearly, Fig. 1 has been prepared, showing the changes of the carbon content of the melt as a function of the carbon content of the charge. In the case of full equilibrium conditions and in the absence of all metalloids the straight line 1 would quantitatively hold good. Considering the normal metalloids present in the gray iron charge (Si, Mn, P and S) the line 2, which cuts the ordinate at 3.3% would govern. The rather scattered values from Table I, which have been indicated on the figure, show that the actual carburization conditions lie considerably below line 2. The limits of low carbon, that is, the smallest possible carburization obtainable with our in some cases almost reach it, the high carbon charges move in the opposite direction.

Carburization is in a high degree dependent upon the quality of the coke as MacKenzie[9] has clearly proved. The curve in Fig. 2 has been drawn from the data shown in his original work. This shows clearly the influence of ash content of the coke on the carbon of the melt. In general this experimental work checks very well with the findings of practical operation, and further with purely theoretical considerations. To cite only one quotation from Nernst:[15] "The velocity of solution, other things being equal, is proportional to the surface of contact and the difference in concentration." MacKenzie also finds that the surface of the coke and its porosity may play a significant role; furthermore, the combustibility or reactivity of the coke is of importance as both MacKenzie and Sipp and Tobias[11] have shown. MacKenzie determined the combustibility by the burning test of Boegehold and found that a fast burning coke gave a higher carbon value. Sipp and Tobias used the Fischer, Breuer and Broche burning test[18] and found that coke with lower reaction temperature (CO formation at 650° C.) carburized more than one with a reaction temperature of 750° C, the figures being on the average 0.4 to 0.2% more according to the carbon concentration of the charge. To sum up: A coke will carburize in proportion to the surface exposed, to the carbon monoxide formed, and to

the rate of burning, but inversely proportional to the ash.

It is apparent that the amount of coke in proportion to the iron is a decisive factor, that is, the more coke charged in the furnace the higher the carbon content of the melt. Numerical values have been found for this and are shown in Fig. 3, which is taken from Piwowarsky, Langebeck & Nipper.[10] Here, also we cannot use a simple proportionality. The reasons for the increase in carburization are principally the raising of the melting zone which provides a thicker bed of incandescent carbon for the molten metal to trickle through, also carbon monoxide formation is increased and a higher temperature is obtained, all of which factors favor carburization.

Piwowarsky and his co-workers investigated the influence of the amount of wind, and came to the surprising conclusion that although the wind was changed from 25% below to 50% above normal there was no direct influence apparent on the carburization, as is shown in Fig. 4. (The sulphur seems to decrease with increasing wind, and consequently increasing rate of melting.) The assumption of Grennan that carburization occurred in the solid condition through a kind of cementation has been disproved by thorough investigation of both metallographical character and careful analysis of the gases. Confirming an investigation already

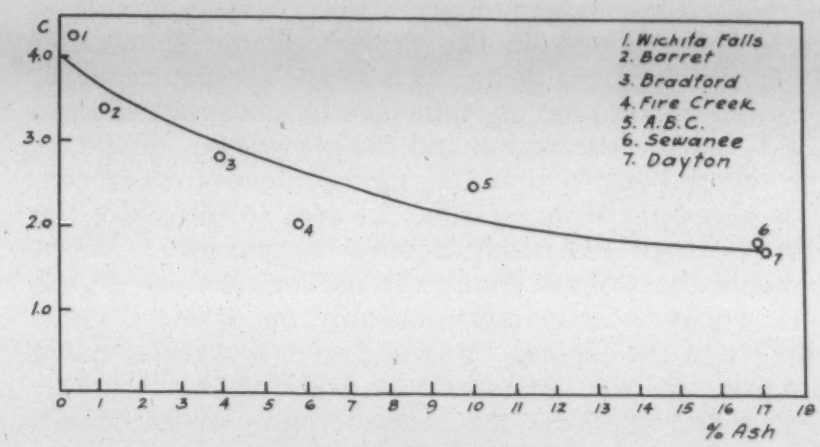


Fig. 2.—After MacKenzie.

so little to do with it, because the low volume of wind makes a thin melting zone and gives more time for oxidation in the stack. With high velocities of wind, oxidation is probably greater in the melting zone, but the other conditions are changed so that they are

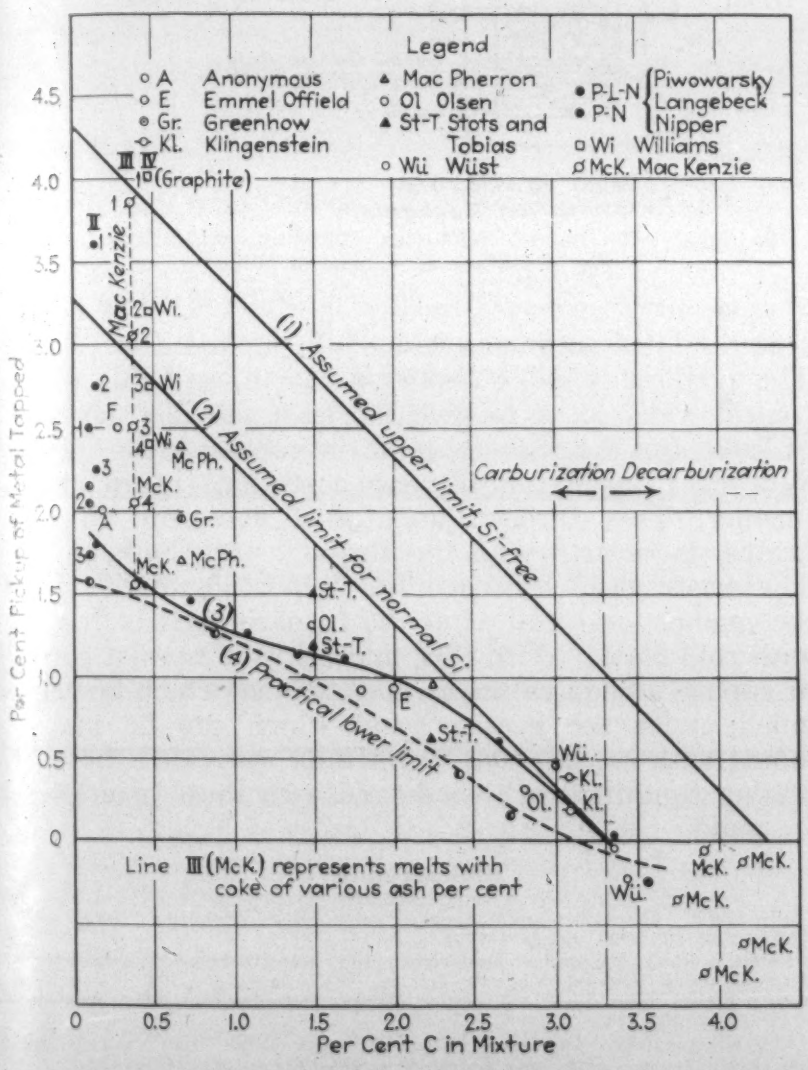


Fig. 1.—Changes in the Carbon Content of the Melt as a Function of the Carbon Content of the Charge.

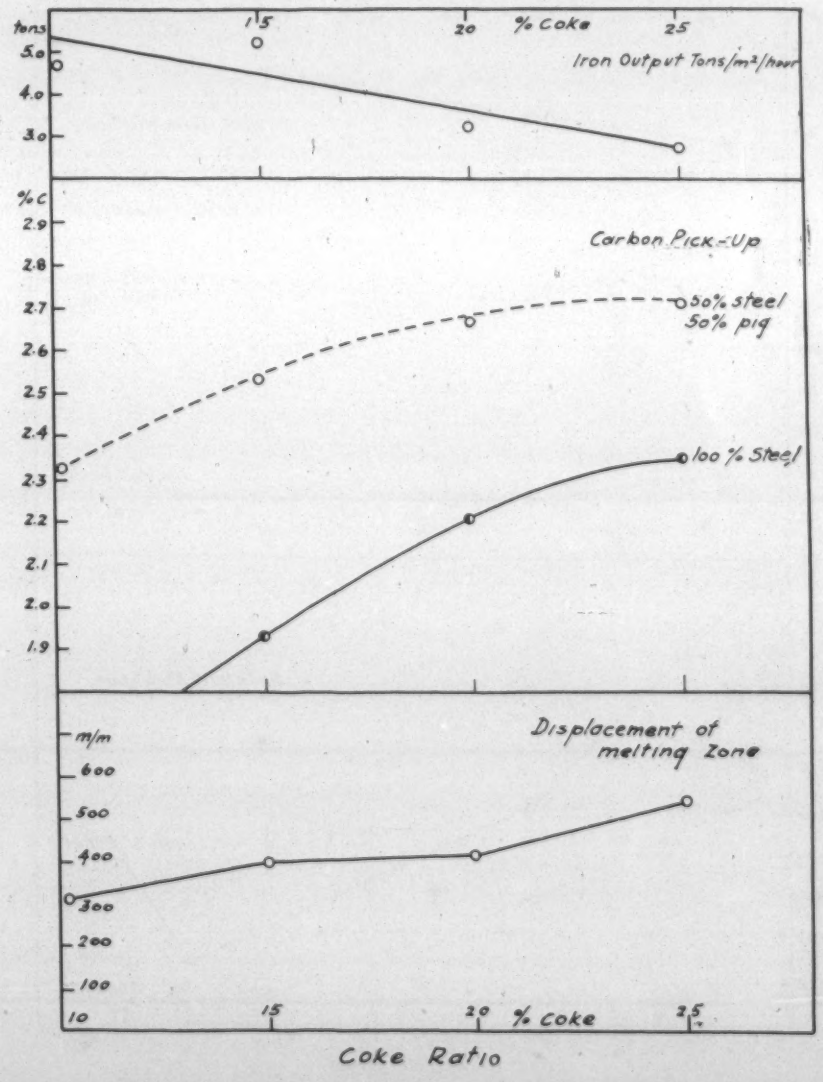


Fig. 3.—After Piwowarsky, Langebeck and Nipper.

made by J. Field,[8] Piwowarsky and his co-workers stated the following hypothesis: "In melting steel scrap in the cupola this undergoes first, above the melting zone, a surface oxidation, which is the greater the longer the charge is in contact with the strongly oxidizing gases of the stack. Carburization first occurs in the fluid condition when the steel is in intimate contact with the incandescent pieces of coke. This is so much the greater the higher the melting zone lies above the tuyeres and the deeper the coke bed is under the tuyeres, or in other words, the longer the time of contact."[20] Schenk's diagram[21] for the 3 phase system, Fe — C — O, is additional evidence against carburization of the solid steel by the stack gases.

This gives the reason why the volume of wind has

favorable to carburization. This conception is illustrated in Fig. 5.

In spite of this discussion we must take it as significant for practical purposes that folks like Emmel and Corsalli use very high wind volume for melting low carbon materials in the cupola when low carbon is desired in the product. Piwowarsky[22] also considers it important in producing a low carbon melt to have a wind volume of 1½ to 2 times the normal. He states

that on account of the common, but erroneous, impression that the melting of high steel charges requires considerably more coke than usual, too much coke is ordinarily used. As a matter of fact, only about 11% is required to produce melting temperatures of 1600° to 1700° C. because of the fact that with high wind volumes a more rapid and intense combustion of coke is reached through the high ratio of carbon dioxide to carbon monoxide. In fact, a heat balance shows that 11% of coke gives plenty of heat for all requirements.

Other factors having influence on carburization are the furnace construction and the operation. So far as the tuyere construction and arrangement is concerned, it is necessary to have sufficient area to introduce the wind without too much increase in pressure. When possible the tuyeres should be in the form of a ring in one plane, occupying practically the whole circumference of the cupola. A second row of tuyeres, above the principal row, increases the depth of the incandescent zone, lengthens the contact time, favors carbon monoxide formation, and in short, favors all conditions which make for carburization, as Sipp and Tobias[11] have shown in a 30" cupola.

The size of the cupola does not appreciably influence carburization provided sufficient wind is introduced to cause the blast to penetrate to the middle so that the oxidizing atmosphere still prevails. Belden[23] in

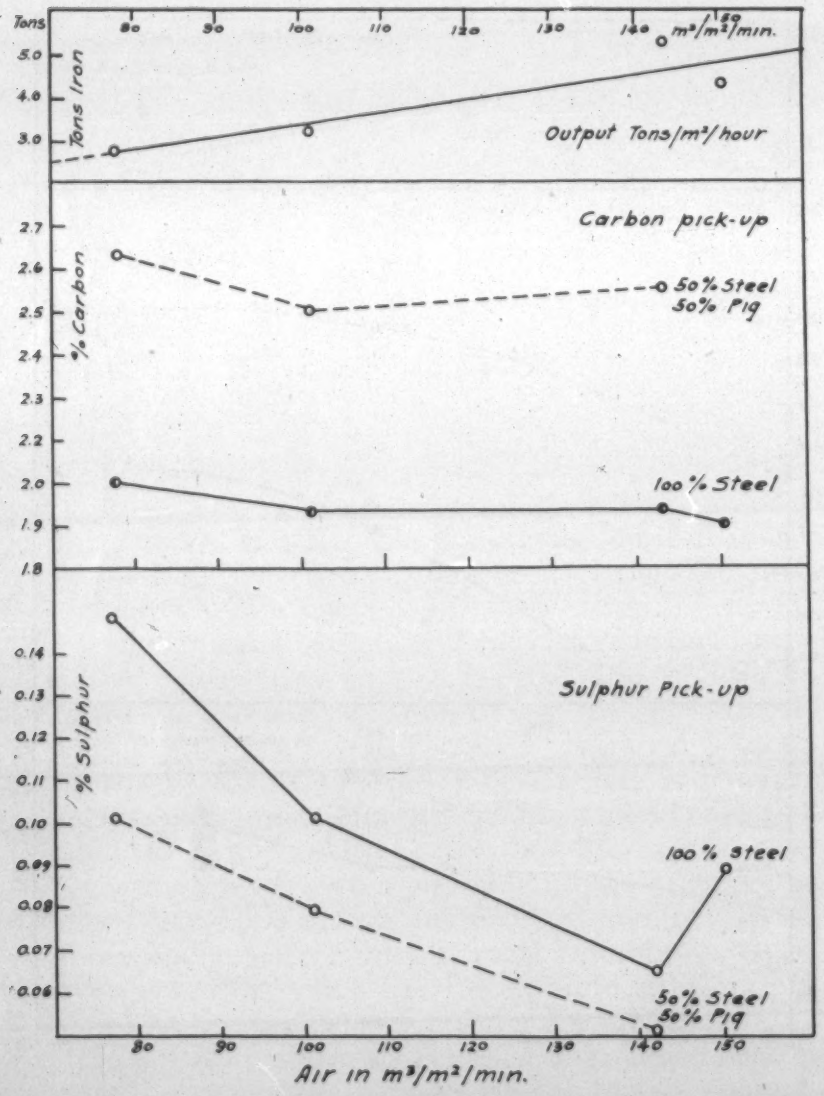
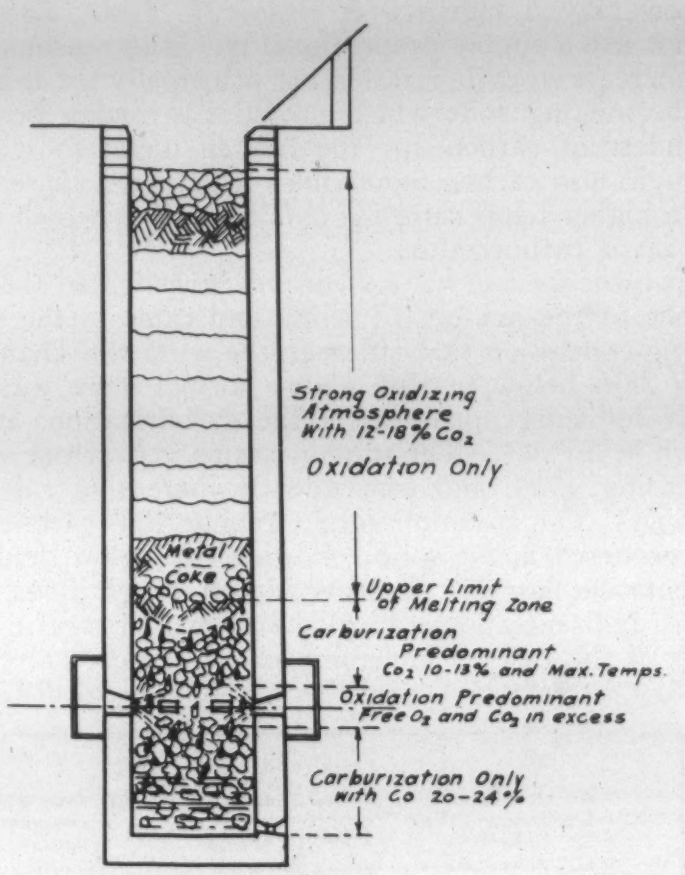


Fig. 4.—After Piwowarsky.

normal cupola operation has shown this atmosphere to consist of approximately 13% CO_2 and 12% CO. Kinney[24] has determined in the blast furnace that up to 40" in front of the tuyeres a strongly oxidizing atmosphere with about 12% CO_2 and 16% CO exists.

From this we may conclude that cupolas under 80 to 100 inches in diameter can not be expected to give any more carburization than a normal size cupola. If, however, a hot blast is used, a certain increase in carburization is to be expected, as one of the authors has found true in a Schürmann cupola, which with a blast temperature of some 500° C. and 50% rail steel addition produced an iron of around 3% carbon against 2.7% for the same size cupola with cold blast.

In conclusion: In order to hold the contact factor as low as possible two requirements should be ob-



Scheme To Illustrate Carburization Mechanism

Fig. 5.—Effect of Volume of Wind.

served: 1st. Continuous flow of the melted iron. 2nd. The smallest possible depth of hearth, and this with conical walls so as to give the least possible amount of coke for the iron to come in contact with. The Wuest[25] furnace fulfills these conditions in an ideal manner. This furnace uses as a reservoir an oil heated flat hearth with the furnace stack built on it. The waste gases are used for preheating the air for the combustion of oil while the furnace itself is driven with cold blast. With this, and also the normal form of cupola, carbon values can be obtained which lie very much under the average, and which can be maintained with considerable uniformity, provided the operating conditions are conducted with these principles in mind.

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(Continued on page 38)

RAPID ELECTROLYTIC PATINA ON COPPER

By G. L. Craig* and C. E. Irion*

COPPER is a favored architectural material in roofs and trim for the prosaic reason that it has almost indefinite life when properly installed, and for the aesthetic reason that, in time, Nature forms a pleasing green patina upon it. Unfortunately, Nature takes her time about this, and lets the copper pass through 10, 20, or more years of an unsightly tarnished stage. During this period, the initially bright metallic copper first changes fairly promptly to a russet brown, then soon to a dirty black. In this latter period, the roof might as well be tar paper as copper insofar as appearance goes.

Architects have therefore desired a practical method for accelerating patina formation, and metallurgists have sought to meet their desires. Vernon and Whitby [1, 2, 3, 4] in England and Freeman and Kirby[5] in the United States have studied the chemistry of patina and have suggested different methods for producing it rapidly.

It had long been thought that the natural patina was a basic carbonate, corresponding to the natural mineral malachite, $CuCO_3$. $Cu(OH)_2$, but analyses of natural patinas made by Vernon and by Freeman from many copper roofs in both England and the United States, showed conclusively that the natural patina of today is the basic sulphate brochantite, $CuSO_4$. 3 $Cu(OH)_2$, which is also a natural mineral. This fact so impressed Vernon and Freeman that both sought to prepare patina of the Brochantite composition directly, by chemical treatment with solutions more or less basic in character, and containing the sulphate radical.

Vernon's Investigations

Vernon first tried solutions of ammonium chloride, sodium chloride, ammoniacal copper sulphate, and other salts, and produced a greenish coloration of the copper, but the coatings discolored "with the first approach of fog," a rather disheartening observation upon coatings to be exposed in England. He then tried repeated applications of ammonium sulphate, the solution being applied twice a day for 6 days, followed by the application of a solution of copper sulphate, sodium hydroxide and ammonium nitrate. By this method, he produced coatings that were not discolored by fog, but which peeled during the first period of frost.

Vernon then tried anodic electrolysis in a magnesium sulphate-potassium bromide solution to which a little magnesium hydroxide was added. The electrolysis has to be carried out at elevated temperature, the solution being heated nearly to boiling. It takes at least 15 minutes to produce a color, and in following Vernon's directions, in experiments at Battelle Memorial Institute, the patina produced was of a whitish, pale color and not a very close duplicate to that of natural patina. The necessity for using a hot solution confines this method to vat treatment of roofing before laying and makes it inapplicable to treatment of old roofs in place.

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Freeman's Investigations

Freeman, in work for the Copper & Brass Research Association, followed other lines of attack. He dipped the copper in ammonium sulphate solution held at 140° F., allowed the adhering solution to dry on the copper and an oxidizing action of the air to take place, redipped and again dried, and continued this intermittent immersion treatment until a patina formed. The hydrogen ion concentration of the solution was found to be important and the solution had to be kept "conditioned" to a definite pH. The time in the drying period was also important.

This method produced a patina of about the composition of brochantite but it contained some ammonia which gave it a color differing from that of natural patina. On driving out the ammonia by soaking in hot water, or by a natural weathering period in the air, it came to the natural patina shade and composition.

Since this method was not applicable to the coating of roofs in place, Freeman continued his work and finally developed the method of repeatedly spraying the copper with a mist of ammonium sulphate solution that had been carefully conditioned by addition of a little copper sulphate and a regulated amount of ammonia water. The copper should have been sand blasted or else chemically cleaned and then allowed to weather until the surface has tarnished enough to allow the spray to lie in separate droplets without their coalescing and running off. The spray is applied 5 times, each application being allowed to dry before the next coat. Some color may appear during the later applications, but its full development requires a subsequent heavy dew or dripping fog, to give the right conditions of humidity for the air to act on the film formed by the dried droplets.

Nature's aid is thus called in and, with suitable coöperation from her, and no bad luck in the shape of a rainstorm that would wash off the coating and necessitate another set of sprayings, the formation of natural patina of brochantite composition is accomplished. This method is suitable for use under correct climatic conditions, and the application of the fundamentals that had been worked out for the intermittent immersion vat method to the problem of putting the patina on a roof in place, is most ingenious.

Where climatic conditions cannot be assured, or where either sandblasting or the delay for weathering between cleaning and the application of the ammonium sulphate solution is inconvenient, there is still need for other simple methods of forming patina. Freeman, moreover, remarks that his method has so far been made applicable only to pure copper and not yet to the other architectural alloys of copper.

Freeman states, and Vernon apparently has a similar

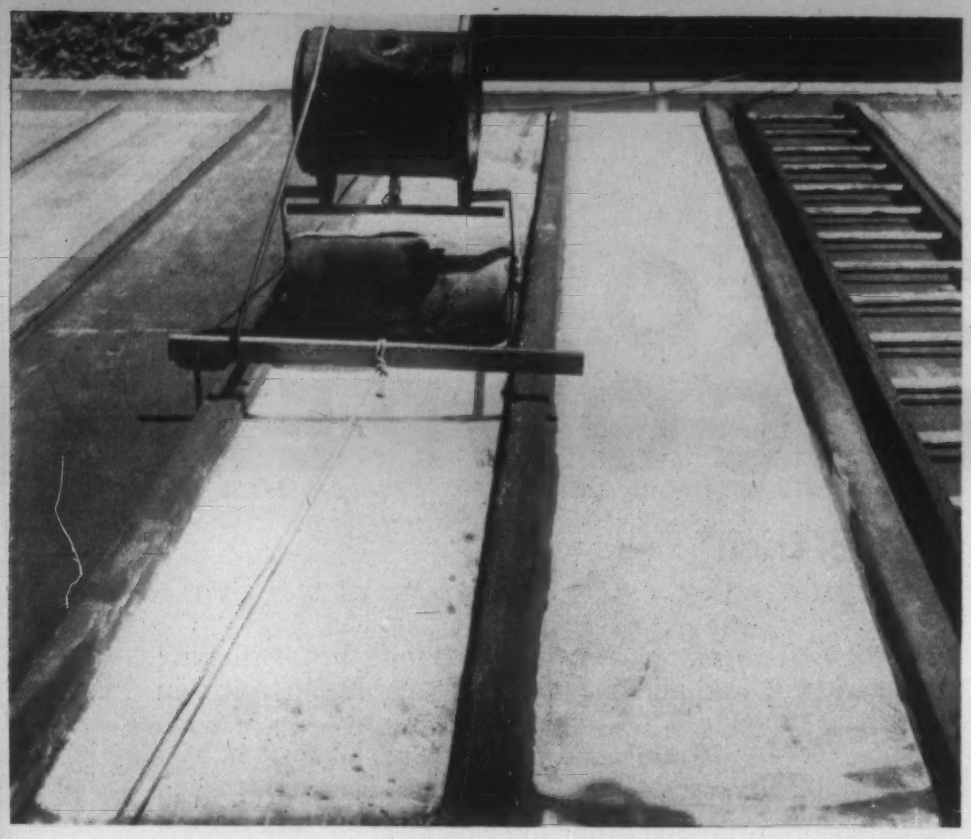

Fig. 1. Apparatus for Applying Carbonate Patina to Roofs and Similar Structures.

opinion, that because analyses of natural patina show it to be brochantite, the basic sulphate, all methods for forming an accelerated patina, reported prior to 1932 (aimed at producing either basic carbonate or some other green compound by chemical methods) were undoubtedly "based on a false premise."

Investigation at Battelle

A different point of view was taken in considering the patina problem at Battelle Memorial Institute. Patina is sought for its looks, not for its analysis, and as long as an artificial patina looks like the natural one, and adheres, it is not very important to the architect or the observer whether it is brochantite or not. The nice balance of basicity of the sulphate solution and the oxidizing action of air or chemicals that the investigators seeking directly to produce basic sulphate had to have, and the dependence on the weather, pointed to the desirability of a more fool-proof method. So a new method was sought, without imposing the limitation that the initial coating must contain sulphate, only that it must look right, and stick on.

Modern analyses of patinas from roofs and objects hundreds of years old, do not necessarily tell what were the initial compositions of their patinas, and even though these coatings now contain sulphate, they may not have contained it when they were first formed. One wonders where the sulphate radical came from before the days when coal began to be burned!

Chemical methods of producing green coatings can be found, but in general, they fail on the score of adherence, so in taking up the problem at Battelle, C. E. Irion, who carried out the first experimental work on the Battelle patina process, decided to try the formation of basic carbonate electrolytically.

This was based on the assumption that perhaps the old belief, discredited by recent commentators, that the natural patina formed in ancient times was basic carbonate, might not have been so far wrong after all, that a carbonate patina ought to look all right, as malachite has the desired color, and that if the coating were applied electrolytically, conditions might be found under which it would be adherent.

Following out this line of attack, Irion found that it was a simple matter to meet the requirements of color and adherence, and that the speed of formation was rapid.

Clean copper, made anode in a soluble alkali carbonate, such as sodium carbonate or bicarbonate, in suitable concentration and with a suitable current density, quickly acquires an adherent coating of basic carbonate which shows a good color match to natural patina. Ammonium carbonate will serve, but of course, it gives a more bluish color. Sodium carbonate is cheap and gives the desired green. No other chemicals are needed in the solution, which does not have to be heated.

Although the color will appear quite promptly in moderately dilute solutions and at low current densities, it is more satisfactory to use fairly concentrated solutions and rather high current densities. Neither of these is critical, but one has to avoid so high a current density that the solution would heat up too much at the anode surface, which would discolor the coating. Solutions too dilute and current densities too low tend to produce a non-adherent deposit. Either carbonate or bicarbonate will serve, but the bicarbonate, baking soda, seems preferable.

About 10% of sodium bicarbonate by weight in water gives a saturated solution. Anything from about a fifth saturated to a fully saturated solution, and a current density from about 1 to 20 amp./dm.^{2} will do. As the coating forms, the current taken by the cell decreases, at a constant applied voltage. As the coating has some rectifying action, coatings can be made by alternating current, though this is not as satisfactory a method. With an 8% solution of $NaHCO_3$ and an initial current density of around 15 amp./dm.^{2}, the coating forms in less than a minute.

Tests on Adherence of Patina

At this stage in the work it seemed desirable to find out whether the coating was as adherent as it seemed to be from the way coated specimens could be bent without flaking of the coating. Repeated heating and cooling from 120° to —40° F. did not dislodge the patina. Coated specimens were then shipped from Columbus to Seattle and back without impairment of the coating. Rain did not wash off the patina from specimens exposed to the weather. The coating produced by the vat method therefore looked promising, so the next effort was directed toward applying it in place on a roof.

Applying Patina to a Roof

The copper roof of Battelle Memorial Institute had at this time been on the building something over 4 years, was in the dirty black stage, and showed no sign of natural patina. A section was cleaned by mopping with an ordinary sulphuric acid pickle and the pickling solution was hosed off.

Following out suggestions by J. D. Sullivan and H. W. Russell of the Battelle staff, a wooden roller 18" long, and 8" diameter was made, having a sheet copper surface covered with several layers of cloth. This resilient, absorbent surface was kept dampened with 5% baking soda solution dripped upon it from holes in a pipe leading to a tank mounted on standards extending up from the axle of the roller. The outfit is shown in Fig. 1. The copper surface of the roller was made cathode, the roof anode, and 40 volts applied. The average current drawn was 60 to 80 amperes. After the patina had been applied, the roof was hosed off with water.

The roof was rather steeply pitched and the roofing copper had shallow corrugations. On passing the roller over the roof at a rate that appeared by eye to be producing good coverage, the rate of application was found to work out at about 50 minutes time of one man to cover a "square" or 100 sq. ft. of roofing, with

the use of 7 lbs. of baking soda in some 17 gallons of water, and the expenditure of about 2½ kw.-hr. Smaller rollers and pads have been used on smaller objects. These need not have the solution drip on them, but may be dipped in a dish of solution from time to time.

The appearance of the patina leads one to think that there is nothing left for Nature to do, because the coating looks much like a normal natural patina, though slightly brighter in hue.

However, Nature does take a hand, and promptly. To trace the progress of the expected change toward basic sulphate, samples were taken at intervals, with the results shown in Fig. 2. In a remarkably short time the basic carbonate started to change to basic sulphate, and the replacement of carbonate by sulphate seemed to go on as rapidly in summer as in winter. Since Battelle is in a residential rather than an industrial district, it had been expected that when the coal fires went out in the spring, the SO_2 content of the air would decrease and the change be slower, but there was no indication of such a slowing up.

As Fig. 2 shows, in less than a year the coating came to the sulphate content of brochantite with loss of carbonate and thus seems to have the composition as well as the appearance of the natural patina that ordinarily takes a score of years to form. Even during the time in which the composition is that of the basic carbonate, the color is practically that of natural patina. There is no flaking of the coating during the change.

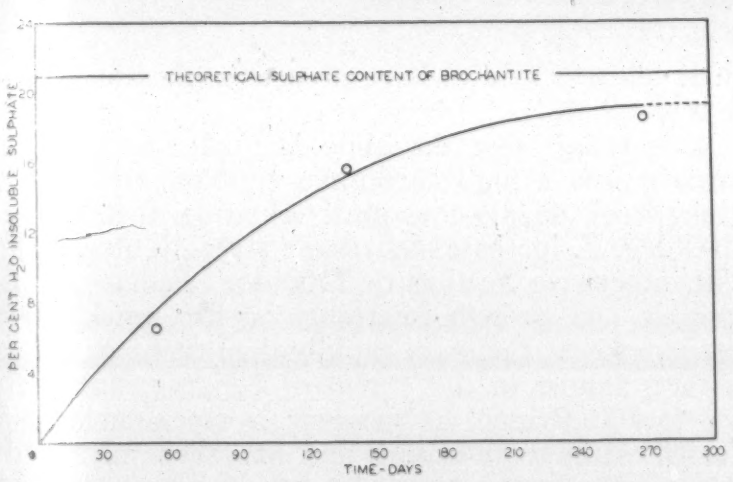

Fig. 2. **Conversion of Carbonate to Basic Sulphate with Time.**

This is logical, because malachite and brochantite are isomorphous. If a very heavy carbonate coating is formed, rubbing the freshly made coating may dislodge a little powder from the surface, but the material next the roof is stubbornly adherent.

About a year and a half has passed since the roof was coated, in which period Columbus weather has ranged from sub-zero to nearly tropical, with heavy snow, heavy rains, periods of very hot drouth and everything in between. The patina is still adherent, and looks just like the natural patina on the roofs of some of the older Ohio State University buildings a few blocks distant.

Not the least interesting feature of the Battelle patina is the fact that it can be applied to almost any copper alloy. Only those alloys very high in nickel seem to give any difficulty in the formation of a well colored adherent patina. A patent, U. S. 1,974,140, for the process and product, in relation both to copper and its alloys, has been issued.

For practical use on old roofs and trim in places where direct current is not available, a farm lighting outfit mounted on a truck would serve. New spandrels, for example, could be vat-coated at the factory and shipped for erection, but only practical experience would tell whether it was best to coat roofing at the factory and patch, on the job, places bared for soldering, or to first lay, and then coat, new roofing.

Fig. 3. **Sheet Copper Lighting Box Coated by Carbonate Method.**

Patina Coating in Eight Hours

An application of the process that required speed, and in which no time for weathering could be allowed, was on the structure shown in Fig. 3. This is an ornamental housing over the switchboard controlling the lighting of an outdoor theater at Ohio State University. The housing was a gift of the Class of 1901 at O. S. U., and was recently dedicated. The contractor was late in finishing the housing and it had to be coated in 24 hours to be ready for dedication. It was coated between 8:00 a. m. and 4 p. m., in time for the ceremony. Had it been erected in 1901, it would only just about have acquired the rich weathered green patina desired by the architect who designed it.

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CLINICS

EDITORIAL COMMENT

(Continued from page A25)

brakes, generators, gaskets, mufflers and even bodies, in the development of cheaper and more efficient cars can hardly be over-estimated.

Last fall *Automotive Industries** devoted the bulk of a whole issue to equipment and parts specially developed by those who cater to the automotive trade. While the engineer and designer have to make sure that an improved part really fits the needs of the particular model they are developing, they recognize that in the evolution of a new muffler, for example, people who are concentrating their thinking on mufflers, and who have studied the requirements of all types of motors, not one type only, are in better shape to understand the fundamentals of muffler design than they are themselves. It does not hurt their pride to look to others for aid; such farming out of specific problems is recognized as the proper way to handle them.

In such a case the desirability of looking to others for aid becomes quite obvious. It is less obvious, but no less real, in other industries.

Self-sufficiency, in these days, is likely to be synonymous with stagnation, so a diagnosis that will lead to the application of advances that have been made, or can more easily be made by others, would make for the better health of many a plant that now keeps its eyes focused on the inside without a glance toward the outside.—H. W. GILLETT.

* Geschelin, J. Fluctuating factors in production call for quick and easy adaptability of equipment. Automotive Industries, Oct. 27, 1934, pages 496-513.

Chuckles

Stellite Outshone

WE cannot content ourselves by hiding this light under the bushel of "Manufacturer's Literature."

The ultimate goal of corrosion resistance has, according to a pamphlet from F. H. Maloney & Co., Houston, Texas, been achieved. The alloy in question is dubbed "NC-5." The makers state: "In setting forth the qualities possessed by this alloy we are not going to give you a quantitative and qualitative analysis of this metal for two reasons: (a) The content of the metal is a secret possessed only by the manufacturer and (b) you couldn't prove that our analysis was correct as we *have not found any agent that will dissolve it, regardless of the degree of concentration.* (Italics theirs.)

Further: "The following acids, regardless of concentration, have no perceptible effect upon it—Hydrochloric, hydroflouric (sic), nitric, sulphuric, acetic, oxalic, tartaric, tannic, chlorine, bromine and hydrogen sulphide (liquid and gas). Alkalis have no effect on it."

It is, however, compared with cupola cast iron, micrographs being shown with the statement: "Both metals are etched with alcohol and nitric acid." Since nitric alone is said to have no action, the alcohol must be responsible!

It is stated that the alloy is made in the electric furnace, has a high chromium content, and a tensile strength of 85,000 lbs. plus. Heating from 1900 to 2100 deg. F. increases its tensile strength about 20 per cent, otherwise heating to 2100 deg. F. has no effect upon it (no growth, warping, or fire cracking). It dissipates heat far more rapidly than cast iron or steel, in fact, almost to the extent of copper; ranges from 375 to 700 Brinell, as desired; is machinable at 550 Brinell without annealing and has been machined at 660 Brinell; cannot be cut by a torch but welds readily to ordinary carbon steel.

If all these claims are true, the statement that it is "ideally suitable for any service where acid, abrasion, and/or high heat are encountered" would appear substantiated, and everybody seeking to produce alloys having any of these properties better lay off and seek no further, for the job is all done. The resulting technological unemployment in research laboratories seems regrettable, but progress must have its price.

H. W. GILLETT.

(Continued from page 34)

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Surface Cracking of Steel Castings During Pickling †

By C. W. Briggs and R. A. Gezelius*

THE LITERATURE contains much information on the phenomenon of hydrogen embrittlement in wrought steel, but the subject has been neglected in reference to steel castings. Steel castings, however, are often found to develop surface cracks during pickling. In order to get some information on the factors leading to susceptibility to pickle-cracking an experimental study of the problem was carried out at the Naval Research Laboratory.

Using a 0.23% C, 0.76% Mn, 0.31% Si steel, cast in standard keel block bars, machined to .505" and annealed ½ hour at 1650°F., furnace cooled, and pickled in 10% H_2SO_4 at 150°F. for 1 hour, the following results were obtained when the bar was tested in the pickling solution, without any opportunity for recovery from hydrogen embrittlement.

	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Not pickled	70,000	30½	42½
Pickled, no inhibitor	65,600	12	15½
Pickled, Quinoline Ethiodide 0.01%	67,000	16	19
Pickled, Rhodine 10%	66,000	16½	19½
Electrolytically pickled, no inhibitor, cathode	66,500	14½	16
Electrolytically pickled, no inhibitor, anode	66,500	19	25

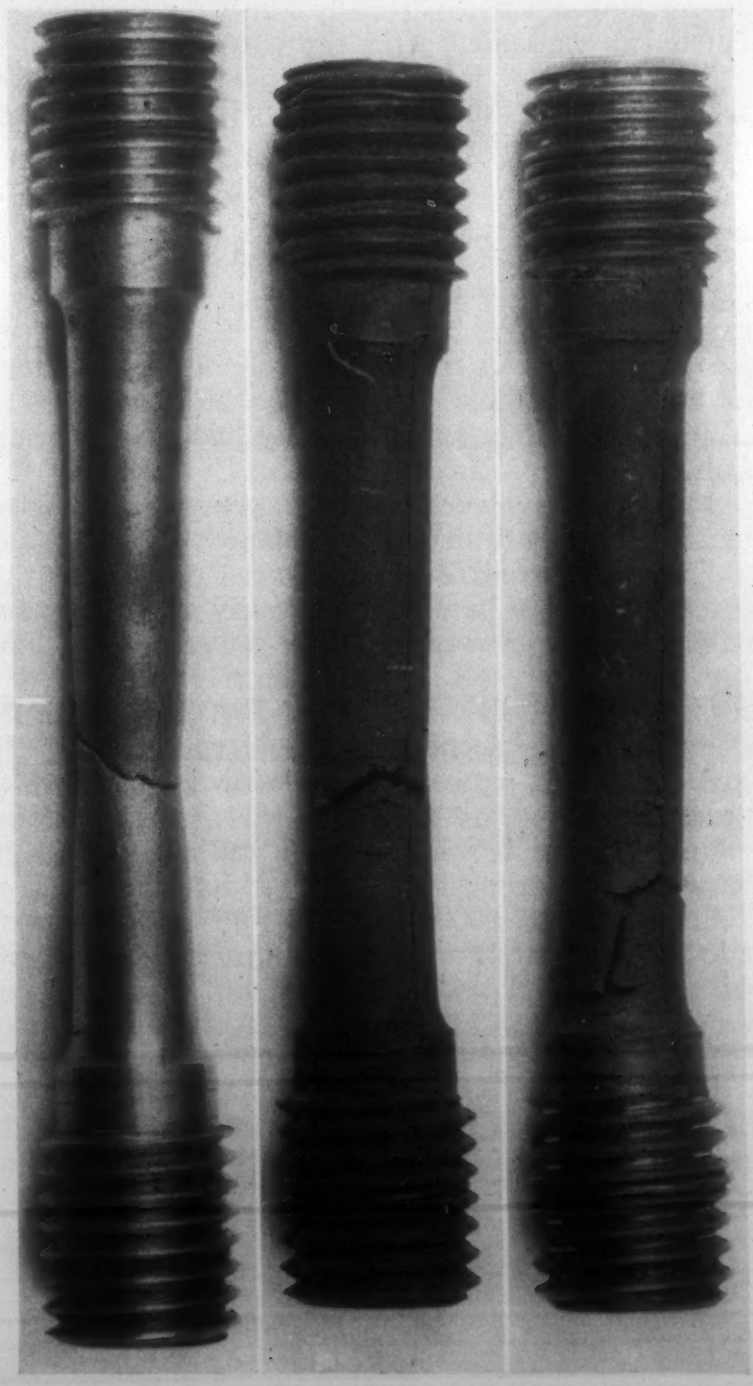
Inhibitors reduce the degree of embrittlement to a slight extent, but do not avoid it.

Recovery was studied by pickling as above for 1 hour, washing in cold water and allowing the specimen to stand at room temperature for various times before testing, as shown below:

Condition	Time in Air Including Testing	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Not pickled	.....	70,000	30½	42½
Pickled	0 (tested in pickle)	65,500	12	15½
Pickled	80 seconds	68,500	12	18
Pickled	8 minutes	68,500	21	22
Pickled	25 minutes	69,000	21½	22½
Pickled	50 minutes	69,000	22	25
Pickled	150 minutes	68,500	22	25½
Pickled	24 hours	69,000	23	26

The recovery from embrittlement is nearly complete in 2 hours at room temperature. Further tests showed that 1 hour in boiling water is equivalent to 3 days at room temperature. The embrittlement of specimens tested in the pickle is really greater than the data shows, because the measured elongation is almost all accounted for by the many small cracks. This is illustrated in Fig. 1 in which A is an unpickled specimen tested in air, and B is one tested in the pickle. C is a specimen pickled in the equipment provided for pickling in the testing machine, but before pulling the specimen in air the acid was pipetted out and wash water added. The small amount of dilute acid remaining around the lower fillet continued to act and to produce hydrogen, while the upper part of the bar was on the way to recovery. The formation of cracks was localized at the place where hydrogen was being formed, and did not appear where there was no continued hydrogen formation.

While the recovered specimens are far less ductile than unpickled ones, it is believed that most of the permanent embrittlement is due not to mere surface roughening, but to what amounts to incipient cracks at the surface, of the same type as those made apparent in Fig. 1B by the application of tensile stress. The cracks do not become visible till the stress rises nearly to the breaking point. The development of incipient cracks in a pickled casting not subjected to external stress is considered to be due to local casting stresses, i.e., tensile stresses at the surface. To get an idea of the magnitude of the stress required to produce dam-



A B C

Fig. 1

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* Division Physical Metallurgy, Naval Research Laboratory, Washington, D. C.

age during pickle, specimens were stressed in the testing machine to 34,000 lbs./in.² and held at that stress during pickling, with the following results:

	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Not pickled	71,000	27	46
Pickled 1 hr. in machine, rapidly tested in acid, no initial stress during pickling	71,000	15½	16½
Pickled 1 hr. in machine at stress of 34,000 lbs./in.² and rapidly tested in acid	71,000	15½	16½
Pickled 1 hr. in machine, tested in acid 8 minutes testing time, no initial stress during pickling	70,000	17	20½
Pickled 1 hr. in machine at 34,000 lbs./in.², removed acid, testing time 8 minutes	71,500	21	25½

This uniformly applied external stress was therefore without effect. The effect of actual deformation prior to pickling was then studied, on annealed specimens, by stretching to definite amounts before pickling, pickling in the usual manner, washing, and allowing the specimens to recover 3 hours before testing. The following results were obtained:

	Tensile Strength lbs./in.²	Yield Strength lbs./in.²	Elongation %	Reduction of Area %
Not stretched, not pickled	71,500	48,000	27	46
Not stretched, pickled...	71,000	51,500	22	29
Stretched ½%, pickled.	72,000	47,500	23	30½
Stretched 1%, pickled.	71,500	47,000	21	28
Stretched 1½%, pickled.	71,500	48,000	21	26
Stretched, 2%, pickled.	72,500	47,500	21	26½

Stretching did not materially affect the pickling embrittlement remaining after recovery.

The same experiment was repeated on "as cast" specimens, which should retain their casting stresses unrelieved, with these results:

	Tensile Strength lbs./in.²	Yield Strength lbs./in.²	Elongation %	Reduction of Area %
Not stretched, not pickled	70,500	35,500	22	31
Not stretched, pickled...	70,500	36,500	17½	25
Stretched ½%, pickled.	70,500	37,500	19½	27
Stretched 1%, pickled.	69,500	38,500	16½	21½
Stretched 1½%, pickled.	71,000	40,000	19	24
Stretched 2%, pickled.	71,000	41,500	18½	24

Again, stretching before pickling had no deleterious result.

Although no evidence had been secured in the above tests for the theory that the permanent bad results of pickling are related to stress, it was considered that these standard test bars were relatively stress free, and further tests were made on bars so cast as to have large internal stresses. Two patterns were used, one the Hall pattern, shown above in Fig. 2 in which the ½" square upper section freezes in compression, the other, the N.R.L. pattern, shown below in Fig. 3 which freezes in tension, as shown by the arrows. Cutting through the member in question and measuring the contraction or expansion indicates that the stress is of the order of 10,000 lbs./in.². Such castings were made in green sand, pickled 45 minutes, washed with cold water, cut off and tested, the cutting and testing taking 12 minutes. The specimens from the Hall pattern, in which compressive stress was present, showed no drop in tensile strength and practically no change in ductility over an unpickled specimen. The N.R.L. specimen, with tensile stress present, gave the following results:

	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
As cast, not pickled	67,500	17	23
As cast, pickled	61,000	7½	13

This very great effect indicates that the bad effect of pickling is chiefly due to the action of internal (surface) tensile stress in the casting itself. It is concluded that if a piece of steel could be obtained entirely free from internal tensile stress, it would exhibit no embrittlement upon pickling.

Since embrittlement is found in annealed specimens, it is indicated that even a full anneal does not completely relieve the stress, and in "commercial" anneals that are merely a normalizing treatment, there is real danger of cracked castings resulting from pickling. Tensile tests of portions of castings that show cracks in pickling show no effect, because recovery has been complete in the body of the metal, and the permanent damage is only at the surface where minute holes and cracks have been etched out. These, of course, cause some stress concentration but unless the casting actually shows visible surface cracks in pickling, its physical properties have not suffered materially.

That the embrittlement is a surface effect, best shown by tensile test bars tested with their surfaces in the pickled condition, is evidenced by the fact that pickling does not seem to produce impact embrittlement on bars cast so they are free to contract. On annealed bars, an unpickled specimen gave 85 ft.-lbs. impact, while a pickled one gave 100, and "as cast" bars gave, unpickled 23½, pickled 47½. A Charpy impact specimen 160 by 20 mm with a 5 mm notch was used.

DESIGNS USED IN PICKLING EXPERIMENTS

Fig. 2. Hall Design

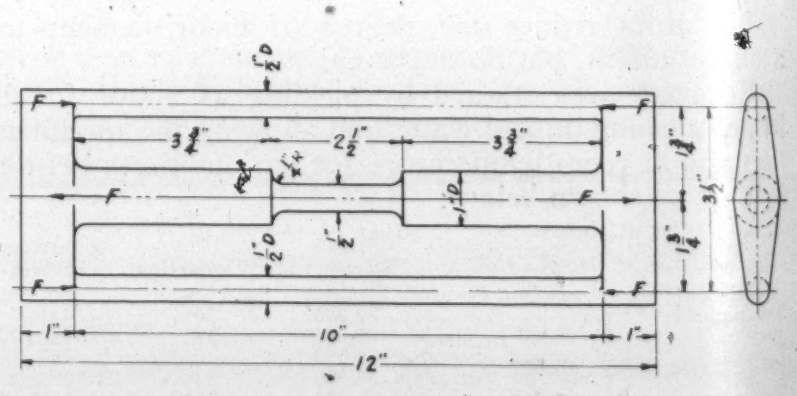


Fig. 3. N. R. L. Design

On bars cast with flanges so as to have contraction (tensile) stress, analogous to that in the lower pattern of Fig. 2, an annealed, unpickled specimen showed 165 ft.-lbs., a pickled one 103, and in the as cast condition, the unpickled bar gave 38½, the pickled 28. On the face of the returns pickling improved the free contracting bars and injured the hindered contracting bars. These data are somewhat confusing and open up the question of the effect of internal stress on impact properties, but they at least indicate that pickling does not ruin the impact properties of cast steel.

The Naval Research Laboratory has recommended to the Bureau of Engineering that, because of high internal stresses in many steel castings, pickling be discontinued, and sand blasting or tumbling be substituted. If sandblasting will not clean intricate openings, the casting should be given a full anneal prior to pickling, to reduce internal stresses, and an inhibitor should be used in pickling.

Some Fundamentals of
SPOT WELDING
Especially of the Light Alloys

By Raymond H. Hobrock *

Part 2

The Shape of the Weld Spot

The shape of the weld spot is undoubtedly of some considerable importance in determining both the static and the fatigue properties of a spot weld. It is apparent that if the greater portion of the spot lies in one of the pieces to be welded (see Fig. 14), and especially if the spot extends to very near the surface of the one piece, the strength of the spot weld is likely to be low. Either the change in structure and the loss in strength due to recrystallization or melting and the relief of some of the inherent stresses of the rolled material, extending through the entire section of one piece, will cause failure at this weakest point, or the entire weld spot may pull off from that piece in which it is least deeply imbedded. Both types of failure have been observed. Those welds in which the weld spot is about evenly divided in both pieces seem to have the best and most consistent strength properties (see Fig. 1).

It is therefore of interest to inquire what it is that influences the shape and distribution of the weld spot. Obviously the shape of the electrodes on the spot welding machine should be of importance. Furthermore, the pressure on these electrodes probably is of influence. Goldmann[7] is inclined to attribute the shape of the weld spot in a large measure to the path of the electric current through the pieces. Because of the lack of any exact information, this path was assumed to be a cylinder extending through the two pieces between the electrodes. It is readily seen, however, that this cannot be true, since otherwise the thickness of the pieces to be welded—should be of but little influence on the shape of the spot. Actually, however, it becomes increasingly difficult to make successful spot welds as the thickness becomes greater, until a thickness is reached where spot welding is impracticable, if not impossible.

In the welding of metal sheets it is possible, under given conditions, to make successful spot welds up to certain thicknesses. This maximum thickness is not determined by the sum of the thicknesses of the two sheets, but, in a remarkable way, is determined by the thickness of the thinnest sheet. The thickness of the heavier sheet is of small importance. For example, in a machine that will just produce a satisfactory weld in two sheets of 4 + 4 mm., it is easily possible to produce a weld in sheets of 1 + 20 mm.

This may be explained as follows. As has been discussed before, pressure (deformation) and temperature during the welding are the important factors in determining whether or not the two pieces can be bound together. The pressure is exerted by the electrodes. The thicker the two sheets, the more the total pressure will distribute itself on the surface of contact of the two sheets. On the other hand, the temperature is determined by the current density (time being constant). Obviously, then, if the surfaces of intimate contact are increased in area, the current density for a given capacity machine will be decreased. If it is assumed that the greatest portion of the current flows only where the sheets are in intimate contact, it is readily seen that in the case of thin sheets or in the case where only one sheet is thin, the surfaces of contact will be small; the current density high, and a satisfactory weld will be possible. With increasing sheet thickness, therefore, the current density will drop off rapidly, so that tremendous currents would be necessary in order to make a weld. Such tremendous currents, on the other hand, would increase the current density in the electrodes and especially at the contact point of the electrode with the sheet so much that melting and burning would occur at that point.

Spot welding is therefore definitely limited by the thickness of the pieces and the resistance of the material. As the resistance of the material decreases, increasingly larger currents are required in order to reach the proper temperature, and so the limiting value of current density at the contact point of the electrode and sheet is reached at smaller thicknesses than for higher resistance materials.

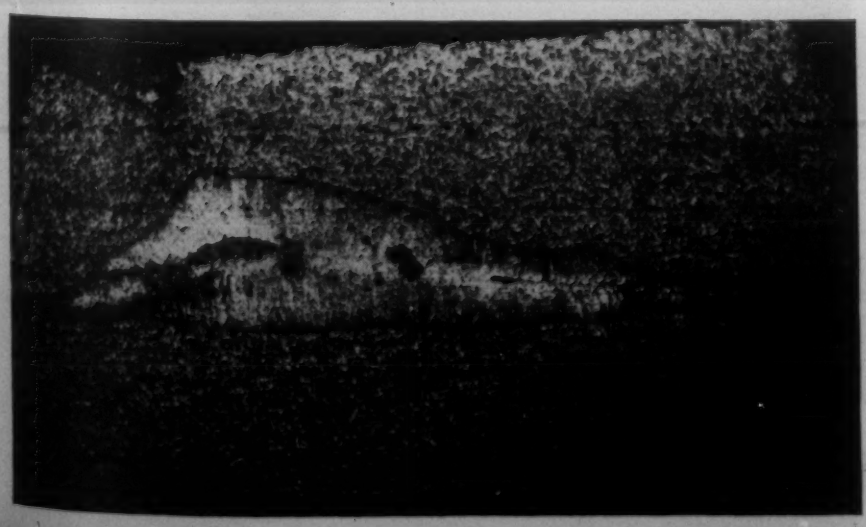
For simple flat surfaced electrodes the path of the current, according to this explanation, is approximately in the form of a truncated cone, in each sheet. The smaller diameter of the cone is determined by the diameter of the electrode, the larger diameter by the thickness of the sheet and the pressure and the physical characteristics of the material. See Fig. 15.

* Daniel Guggenheim Airship Institute, Akron, Ohio.

[6] E. Scheuer. *Hauszeitschrift der V. A. W. Ertfwerk*, Vol. 3, 1931, page 134.

[7] F. Goldmann. *Elektroschweissung*, Vol. 2, 1931, page 8.

Fig. 14. Spot weld in aluminum alloy. Spot mostly in one sheet.



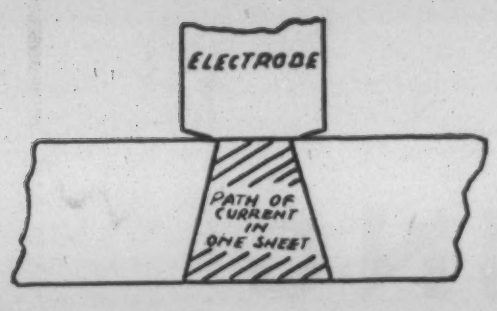


Fig. 15. The probable path of the welding current in one sheet.

This explanation, of importance in a consideration of the limiting conditions for spot welding, does not, however, give any direct information as to the shape of the weld spot. It indicates that at least one dimension of the spot (the dimension parallel to the surface of separation of the sheets) will be a function of the electrode shape, the strength characteristics of the material, the thickness of the sheets, and the pressure on the electrodes.

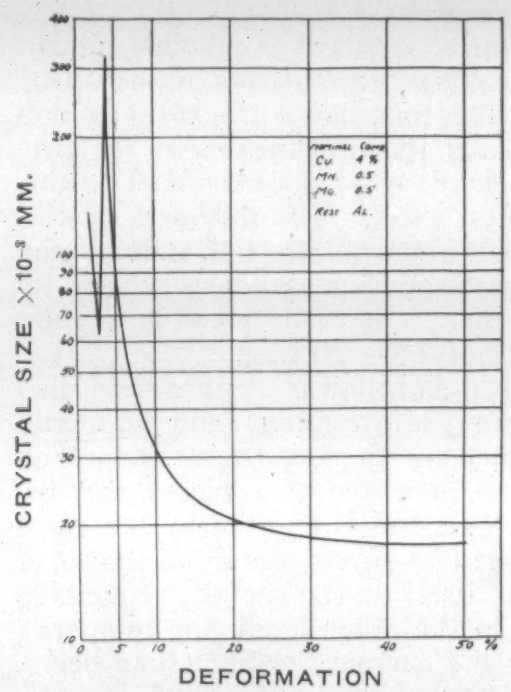


Fig. 16. Recrystallization diagram for a strong aluminum alloy, deformed and then recrystallized at 550° C.

Now, if we again examine the recrystallization diagram shown in Fig. 4 and in Fig. 16 for 550° C. alone, it is seen that there is a region of deformation below about 5%, in which there is a tendency for the crystals to grow large. If an annealed* specimen of this material is deformed by compression and then allowed to recrystallize at 550° C., those portions of the specimen that had received deformations below 5% will grow large crystals, while those portions deformed more than 5% will remain small or become even smaller than the crystals in the original material. Figs. 17 and 18 show such deformed and recrystallized specimens. Fig. 17 shows such a specimen deformed between stiff parallel plates. Because of the friction between the pressing plates and the material being pressed, that part of the material in contact with the plates is hindered from expanding laterally, bulging occurs along the sides, and there exists in the neighborhood of the edges a non-uniform distribution of compressive stress. The region a in Fig. 17 is therefore a section through a region of the material that has not been deformed. In brittle materials of cylindrical shape this cone (cone of fracture) can often be discovered in the broken specimen.

X-ray and microscopic crystal counts inside the areas a and a′ in Fig. 17 show that the crystals have neither increased nor decreased in size after recrystal-

* Annealed or heat-treated specimens show little difference in secondary recrystallization. See Bohner and Vogel, *Zeitschrift fuer Metallkunde*, Vol. 24, No. 8, p. 169.

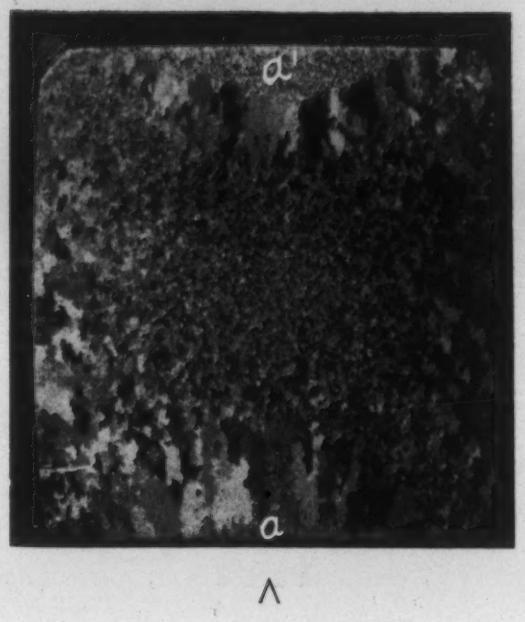
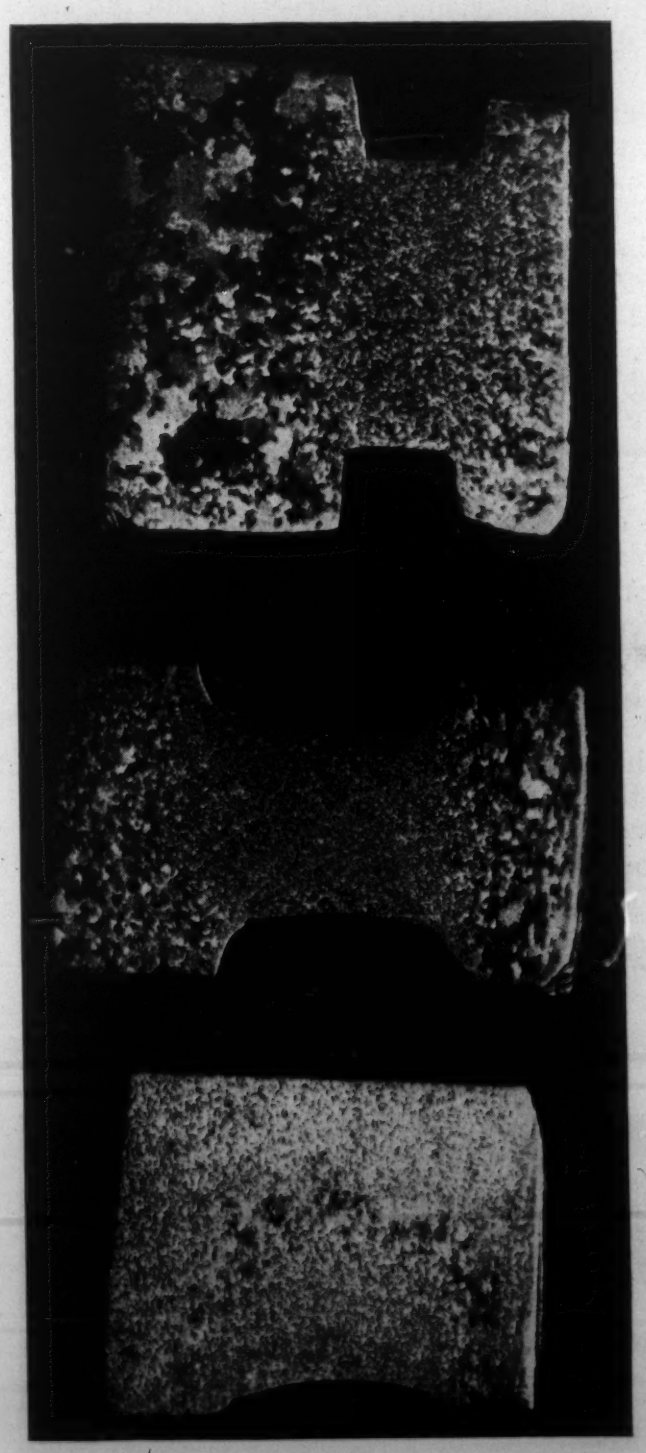


Fig. 17. Specimen of a strong aluminum alloy deformed between stiff flat plates and recrystallized at 550° C.

Fig. 18. Deformed and recrystallized specimens of a strong aluminum alloy.



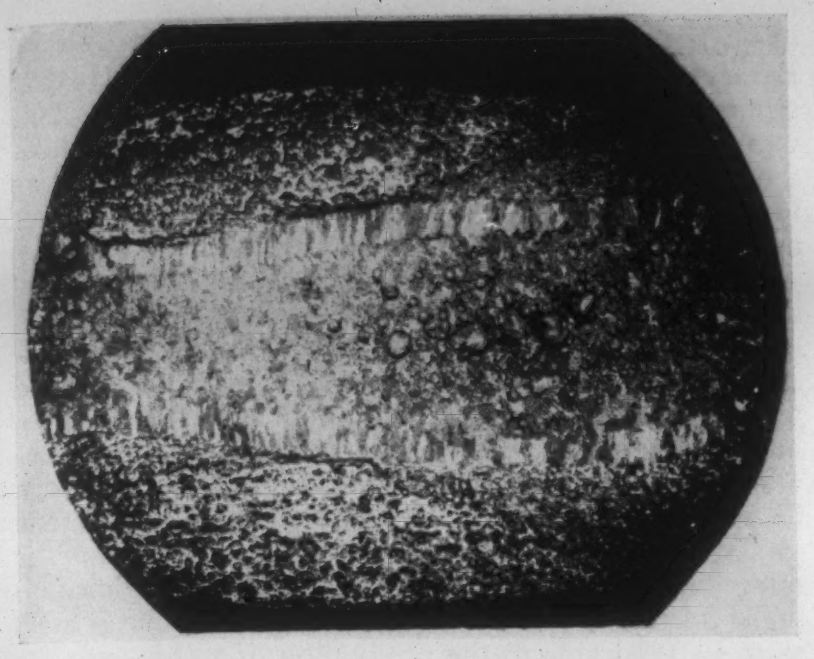


Fig. 19. Longitudinal section of a seam weld showing various structures.

lization. It can therefore be assumed that this cone did not receive a permanent deformation.

If the weld is due to recrystallization, then the shape of the weld spot will in some way be associated with recrystallization phenomena. Examination of a typical weld spot (see Fig. 19) shows definite regions of crystals with different sizes. For example, in Fig. 19 there are at least three regions in which the crystal size is quite different; an outer region of large crystals, an intermediate region of smaller crystals, and the inner region of very small crystals. These regions may be the result of different deformations and different temperatures.

It is proposed, therefore, that the shape of the weld spot as seen from etching microscopic specimens is due to the deformations in the material and the temperature.

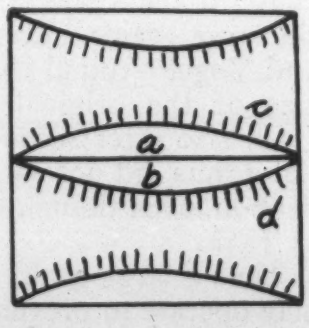


Fig. 20. Sketch illustrating the formation of weld spot shape due to deformation between flat electrodes and recrystallization.

Consider Fig. 20. In this figure two such specimens as shown in Fig. 17 are considered placed one upon the other. It is seen that the cones of minimum deformation give substantially the shape of the weld spot shown in Fig. 1. The regions a and b are regions of no deformation before the current flows and the temperature rises. They are, moreover, the regions within which the highest temperature is reached. This region becomes soft when heated, is deformed the most, and recrystallizes forming a weld. The regions c and d, on the other hand, have been regions of small deformation—large crystals will grow in these regions at comparatively low temperatures, even at room temperature in some cases. Therefore these surrounding bands of large crystals are probably grown immediately before or at the same time that the regions a and b become soft enough for deformation and regrowth. It is therefore reasonable to assume that electrode shape and pressure might influence greatly the size, shape, and strength properties of the weld spot. The strength properties are strongly influenced by the crystal size. Deformations between flat electrodes may always produce the region of small deformation around the region of no deformation, and so may always produce a layer on the outside of the spot in which the crystals are comparatively large. On the other hand, it may be possible to construct electrodes so shaped as to produce a uniform stress distribution at the interfacial surfaces of contact, so that at the welding temperature recrystallization will proceed outward from the surfaces of contact with a constant and uniform crystal size and without bands or layers of different size and structure.

Seibel and Pomp[8] suggested a method for the uniform distribution of stresses in cylinders loaded in compression. The method consists in loading the cylinders, not between two flat plates, but between two cones fitted in each end of the cylinder under test. The generatrices of these cones should make an angle with the plane of compression equal to the angle of friction between the material being compressed and the material constituting the cones. This angle, for most metals on metal, varies between 8.5° and 11.5°. Therefore, electrodes of a conical shape with about the indicated angles should produce a uniform stress distribution and a uniform deformation. It must be remarked, however, that this consideration holds strictly only for the case of loading of entire areas of single specimens, and would not necessarily hold for the case

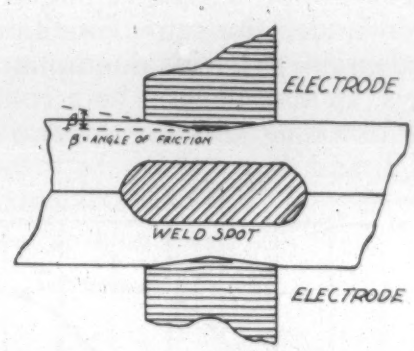


Fig. 21. Probable shape of weld spot made with conical electrodes of proper angle.

in which comparatively small areas are compressed in a large sheet. For our present consideration, however, it is sufficient to assume the above given angles —investigations now under way at this institute will give more exact information as to the most desirable angles of electrode shapes and their relations to sheet thickness, etc.

Fig. 21 shows the shape of the weld spot that might be expected from such conical electrodes, while Fig. 22 shows an actual weld spot made with electrodes having an angle of approximately 7°.*

[8]Seibel & Pomp. *Mitteilungen aus dem Kaiser Wilhelm Institut fuer Eisenforschung*, Vol. 9, 1929, page 157.

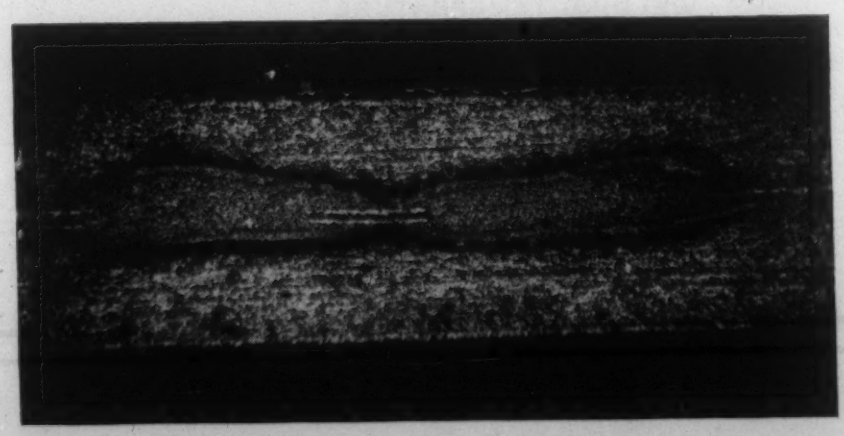


Fig. 22. Spot weld in Alclad, made with electrodes having a 7° angle. Note the unmelted portion of the pure Al coating remaining at the center of the spot.

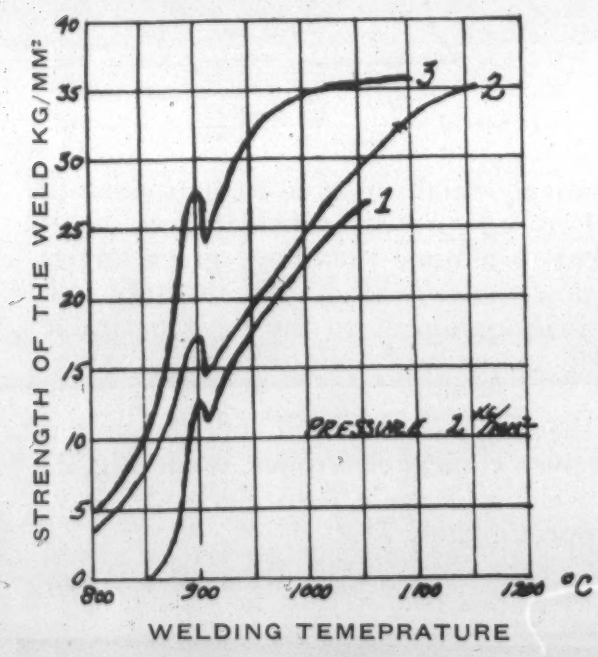
* It is interesting to note in this connection that some investigators working with the spot welding of aluminum and the aluminum alloys have arrived at approximately the same angle and conical electrodes as the most satisfactory so far used. Their conclusions were based on experimental results and was explained on the basis that this shape of electrode permitted the proper rate of penetration of the electrode into the metal as the weld was made. Thus as the welding progressed the area of contact of the electrode with the metal increased. (See Spot Welding Aluminum Alloys. D. I. Bohn. *Aviation*, Vol. 33, Aug. 1934, page 256.)

In concluding this discussion of spot shape, it should be emphasized that the relation of spot shape and structure to static strength and fatigue properties has not yet been sufficiently well investigated (at least for the aluminum alloys) to permit of any definite statement regarding the most desirable kind. After such investigations have been concluded, however, it may be possible to produce the desired spot size and shape by the considerations discussed in this section of the paper.

Influence of the Crystal Size of the Metal to be Welded

H. Esser[4] has studied the effect of pressure, temperature, surface conditions, and crystal size in the original material, on the strength of pressure welds (butt-welds) in electrolytic iron. Since electric resistance welds resemble in many ways such pressure welds, it is interesting to examine the results of these investigations in the light of the proposed explanation of the mechanism of spot welding.

Fig. 23 shows how the strength of the welded joint varied with material of different initial grain size. Curve 3 is for material with very small grain size, 2 for material with medium grain size, and 1 for material with a rather large grain size. These grain sizes do not become as large in the case of electrolytic iron under the same conditions of deformation as do the grain sizes in aluminum and most aluminum alloys, as may be seen by a comparison of the recrystallization diagrams for the two materials shown in Figs. 2, 3, and 4.



Curve 3 = small grain size.

Curve 2 = intermediate grain size.

Curve 1 = large grain size.

Fig. 23. Showing the influence of grain size of original material on strength of pressure welds in electrolytic iron.

This effect of the original grain size on the strength of the weld can be ascribed to two effects. The first is the effect on the ease of welding itself—that is, on how completely the recrystallized grains will grow across the face of separation. Esser offers as an explanation that weldability is in some way connected with the strength properties of the material, and that there are certain crystal orientations that will grow together more readily than others. Thus, the hardness of a single crystal of electrolytic iron varies on the various faces; it is the smallest on the cube face (100) planes, greater on the oktaeder (111) planes, and greatest on the rhombendodekaeder (110) planes. This hardness, influencing as it does the deformation under a given load, may influence the weldability directly or the hardness itself may be the result of the magnitude of the forces acting in the crystal in the different directions. In either case the result is that the crystals do grow more readily on some faces than on others. Esser therefore very simply explains the increased strength of the fine-grained material on the basis that with many small grains in the interface, the chances are greater that many of them will be so oriented as to grow readily, than in the case where there are but a few large grains.

If this explanation is true, then it might be of considerable importance to examine the influence of such grain orientation on the strength of welds in aluminum and the light alloys, since in many cases cold working of the heat-treated metal is carried out to increase the physical properties. This cold work does result in a preferred orientation of the grain, as can be seen from Fig. 24.* If spot welds are to be made in sheet material with such preferred orientation, it is interesting, and perhaps of considerable importance, to know whether or not this preferred orientation is such as to be favorable to the production of welds with the highest strengths. Such experiments are being carried out at this institute.

The second effect of the grain size of the material may be in its influence on the size of the grain grown upon recrystallization—that is, upon welding. Large grains in the spot are to be avoided, of course, because of the lower strength properties associated with the large grains. Contrary to usual opinion,[9] Boehner and Vogel[10] found that for aluminum alloys the grain size of the original material greatly influenced the grain size after secondary recrystallization. Large initial grains did not change much in size upon recrystallization, even though they had been deformed as much as 15%.

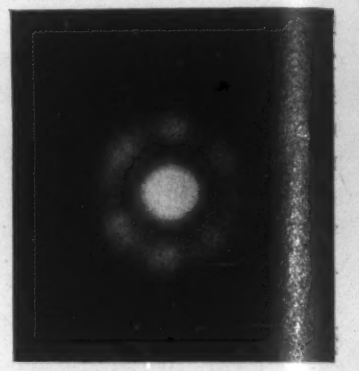


Fig. 24. Polychromatic pin-hole X-ray diffraction pattern of a cold-rolled strong aluminum alloy showing preferred orientation (symmetrical arrangement of large spots).

Thus a large grain size in the material to be welded may operate to prevent good crystal growth across the interface, or, if such crystal growth does occur, the grain size in the weld spot may be large. Both of these effects tend toward the production of a weld of low strength.

The crystal size in the weld spot is also influenced by the amount of deformation at the spot region. In the case of annealed material, this deformation is produced by pressure on the electrodes only, while in material that has been cold worked after heat-treatment, a certain deformation is already inherent in the sheet. The total deformation should be great enough so that upon recrystallization the grains will grow small. Thus, it may be seen from Fig. 4 that the deformation should exceed at least 5% for this alloy. On the other hand, deformations above about 30% have little effect toward a decrease in the grain size. Again the investigations of Esser show this effect in a remarkable way. Fig. 25 shows the relation between the strength of the weld and the specific pressure used in

* See also C. B. Hollabaugh & W. P. Davey. Preferred Orientation Produced by Cold Rolling of Aluminum, Nickel and Silver. *Metals & Alloys*, Vol. 2, 1931, page 247.

[9] J. Czochralski. Moderne Metallkunde. Julius Springer, Berlin, 1924.

[10] Bohner & Vogel. *Zeitschrift fuer Metallkunde*, Vol. 24, 1932, No. 8. page 169.

making the weld (for electrolytic iron). At a specific pressure of 1 kg./mm.² there was a small difference in the strength of the welds made at the different temperatures. This may be ascribed to the fact that the pressure used was not great enough to produce a sufficiently large deformation to insure small grain size. However, a small increase in pressure produced increasingly larger deformations as the temperature was increased and the strength of the iron decreased. A very small increase in pressure above 1 kg./mm.² caused a permanent deformation in the material at 975° C., great enough to cause very small crystals to grow upon recrystallization, and thus increase the strength. On the other hand, such a small increase in specific pressure had but little effect in the deformation of the material at the lowest temperature, and so had but little effect on the grain size. However, at all temperatures a specific pressure is reached which represents the maximum strength to be obtained at that temperature. At this optimum pressure, the strength of the weld is a function of the temperature only; the deformation is sufficient to cause the growth of almost the smallest grains that will grow at the given temperature. Deformations beyond this will have but little effect on grain size—this may be seen from the recrystallization diagrams.

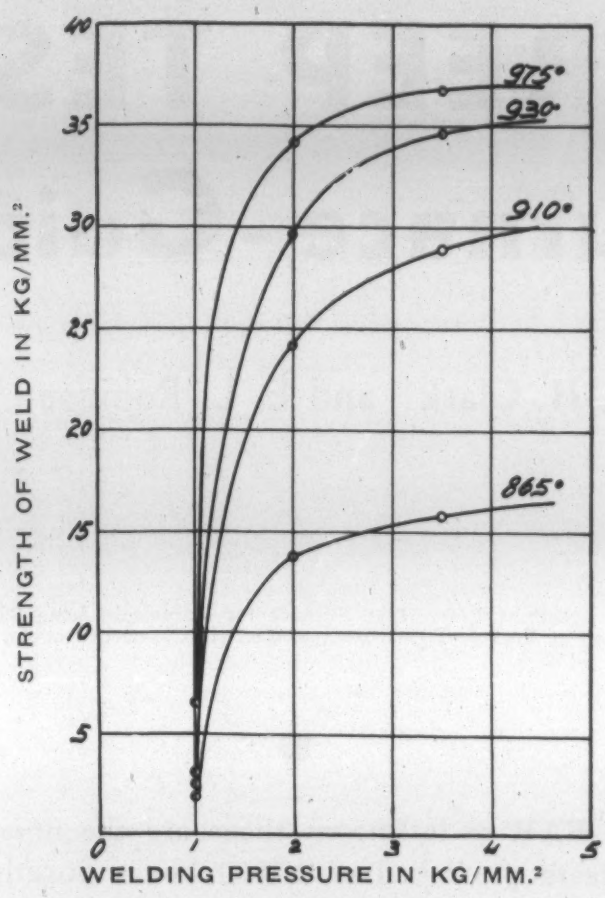
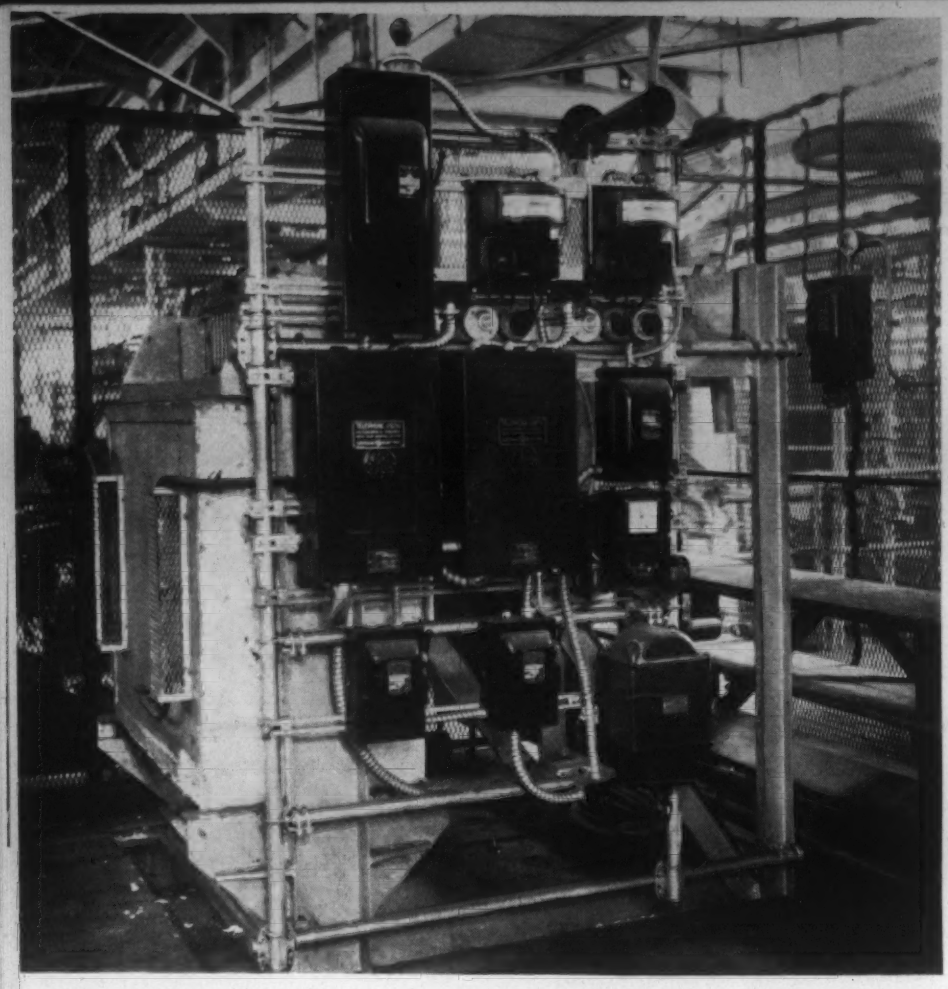


Fig. 25. Diagram showing the relation between welding pressure and strength of the weld at various temperatures. For pressure welds in electrolytic iron. (Esser)

There are undoubtedly other conditions effected by the pressure in Esser's experiments, such as the influence of the pressure in simply bringing the two surfaces into intimate contact and the breaking through of the layer of oxide and nitride film and the layer of adsorbed gases. However, the experiments were carried out in high vacuum, with carefully polished surfaces, so that the influence of the last mentioned factors should at least be much reduced.

(Concluded in March issue)



An Automatic CREEP TEST Furnace-Guide

P. H. Clark* and E. L. Robinson**

Multiple Specimen Creep Test Furnace for Automatic Long Time Test. Installed in Turbine Dept., General Electric Co., Schenectady, N. Y.

CREEP TESTS, to determine allowable stress values to assure low rates of flow of the many alloy steels being introduced by many steel companies, are being carried on by steel companies, manufacturers and research laboratories for obtaining data which can be relied upon for designing purposes.

At the present time it is safe to estimate that considerably more than one hundred such furnaces are in use throughout this country, most of which are of the single specimen type.

During the past 4 years the General Electric Company has operated 8 furnaces, providing test space for 40 tensile test bars ranging from 10 to 20 inches gage lengths.

More than 2 years ago the Turbine Engineering Department installed its latest creep test furnace designed in coöperation with the Industrial Heating Engineering Department, capable of running 12 specimens of 20 inch gage length at the same time and under closely identical temperature conditions. This furnace was built primarily for automatic operation so as to require a minimum of supervision with acceptable engineering accuracy.

Experience over the past 4 years had demonstrated that highly accurate tests limited to a few weeks' duration were inadequate to give the long time behavior of materials under stress at high temperature. Tests of many months' duration were needed lasting several years if possible. For such a task, the daily supervision required by highly accurate and intricate controls appeared inappropriate.

Test experience had shown that rates constant for several weeks would be just as constant the next year but at a very different slope. The elapsed time or, even more important, the accumulated strain is of much greater importance than the precise rate in the early months which loses its significance as time goes on. What was needed was to subject the bars to conditions of stress and temperature controlled as steadily as might be with good commercial instruments and then leave them alone except for a monthly reading. As a matter of fact the controls proved more accurate than had been anticipated and the results obtained so far have been gratifying beyond expectation. Taking all circumstances into account, it is believed that the results obtained from this furnace are of an accuracy not exceeded by any other furnace described in the technical press.

This furnace is illustrated by sketch Fig. 1 and consists of an electric furnace built in 2 sections, a front and back, which are clamped together air-tight against a non-corrodible metal compartment divided at top and bottom into 13 chambers, each approximately 2 inches square, used for packing and to facilitate assembly and removing of single specimens without disturbing other tests.

The outside casing is of welded construction and is lined with approximately 7 inches of heat insulation brick, thus making a heating chamber approximately 36 inches long, 26 inches high and 8⅜ inches wide. Electric heating elements are mounted on 2 opposite walls in 3 independent circuits, each winding distributed differently so as to give very uniform heating of the specimens suspended in the chambered compartment. In addition to the heating elements mounted on each side wall, there is also another unit on the floor or bottom of the heating chamber.

The metal compartment mentioned above, being a shield between the direct radiation of the electric heating units and the specimens, gives added assurance of uniform temperature distribution.

Fig. 1 also illustrates the method of supporting the specimens and applying a predetermined load. There are 3 fundamental measurements in making creep tests; load, temperature, and extension. (It is also necessary to know the length and cross section of the specimen, but with a long uniform specimen these are both secured with great accuracy.) Of the 3 fundamental measurements, load is usually the easiest to measure accurately. It will be noted that a single lever is used with a maximum ratio of 30 to 1. Instead of knife edges, ordinary pins are used, which makes for ease of accurate location and measurement of lever arm. Before the furnace was placed in service there was some uncertainty as to the possible friction in the pins and whether the levers would rise and fall with temperature fluctuations or whether they would stick, thus causing stress fluctuations in the specimens. The curve, showing "Temperature cycle due to Control" was actually made on the end of one of the loading levers, showing its

* Industrial Heating Engineering Department, General Electric Co.
** Turbine Engineering Department, General Electric Co.

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AS FAR as is known these are the first creep tests published of 10,000 hours duration.

It is to be regretted that in these tests run 10,000 hours, the apparatus was not located where the room temperature could be controlled or that the specimen temperatures were not controlled in such a manner as to be unaffected by the large room temperature change with the seasons, thus making corrections of the test data obtained unnecessary.

The increasing rate of elongation for No. 611 during the latter part of the test period, if true, opens wide for discussion the dependability of extrapolation from test data obtained over shorter periods of time.—

HOWARD C. CROSS

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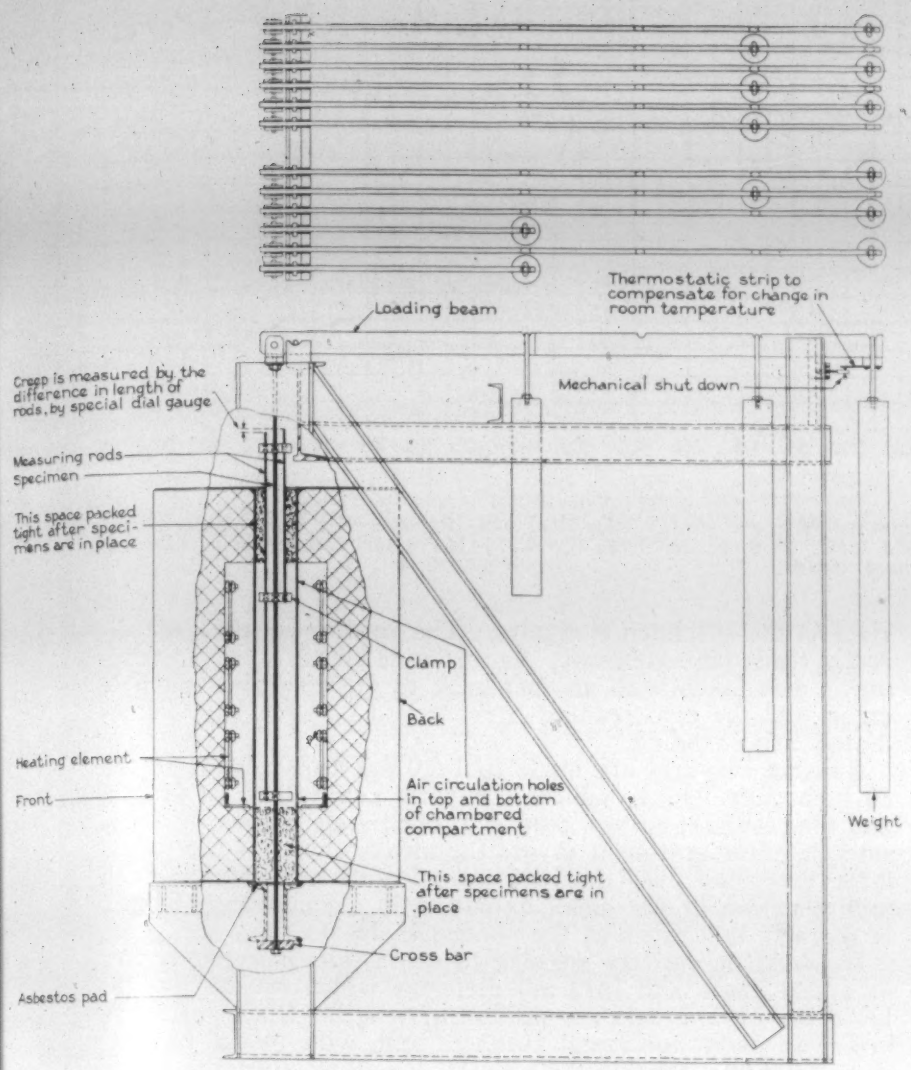

Thermostatic strip to compensate for change in room temperature
Loading beam
Creep is measured by the difference in length of rods, by special dial gauge
Mechanical shut down
Measuring rods
Specimen
This space packed tight after specimens are in place
Clamp
Back
Heating element
Front
Air circulation holes in top and bottom of chambered compartment
Weight
This space packed tight after specimens are in place
Cross bar
Asbestos pad

Diagrammatic sketch of Automatic Creep Test Furnace.

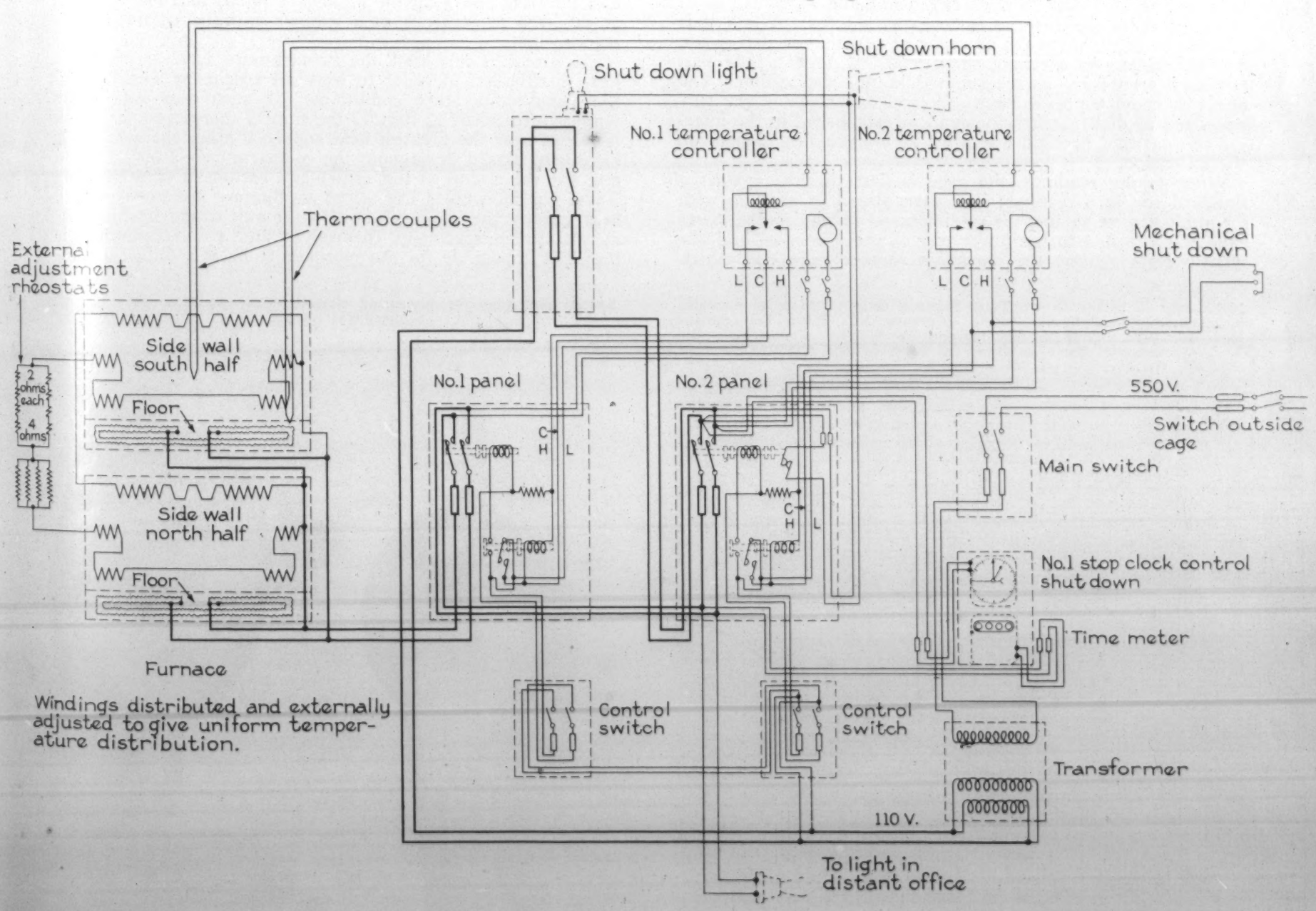
actual rise and fall with the control cycle. Frictional measurements made on the loading beams under actual conditions of operation with packings in place and loads on show the total friction to be approximately ½% of the applied load, no indication being as large as 1%. When first placed in service this furnace was operated for a week with a vigorously unbalanced motor bolted tightly to the frame without any very noticeable effect on the creep curves.

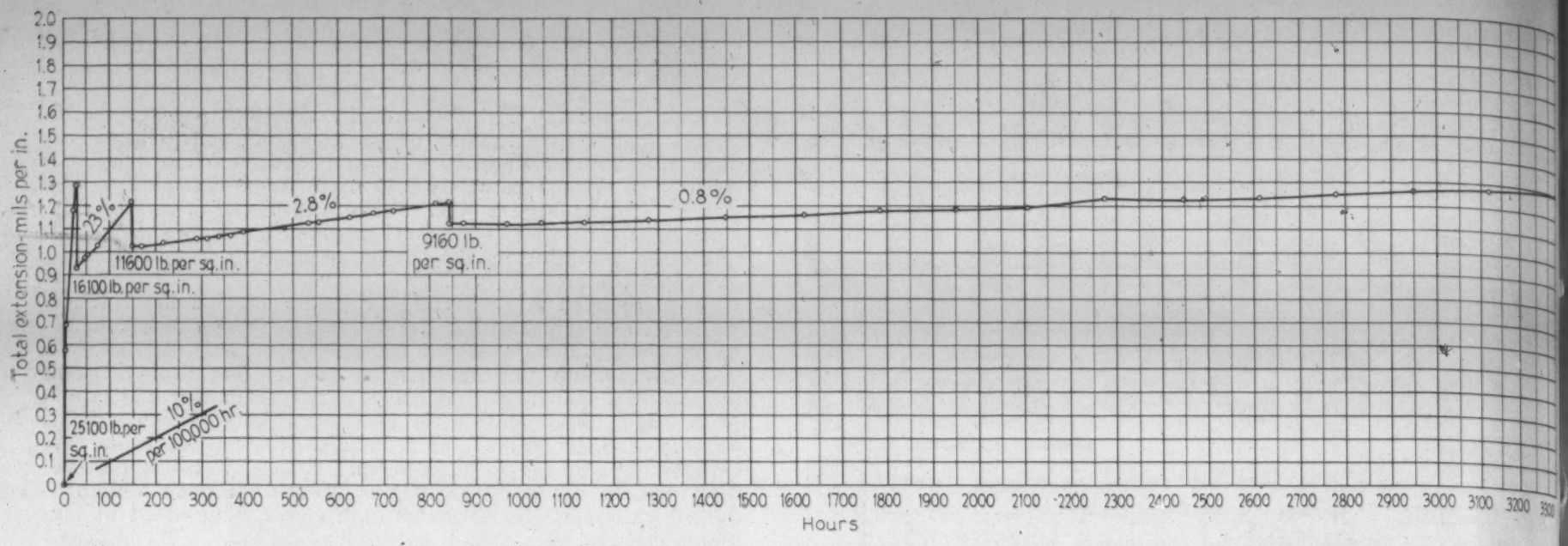
The specimen at each end is threaded outside the furnace and at room temperature. The strength is so much greater in the cold that no upsetting or increase of section is needed and the smooth uniform bar is easy to pack for thermal insulation and involves much less heat leak than would occur with large shackles inside the furnace. The specimen is held in place at the bottom by being passed through the cross bar which closes up the space between 2 channel irons supporting the furnace; a nut is threaded on to the specimen and then pulled up against the cross bar. A clevis is threaded to the upper end and then pinned to the loading bar.

The specimen is just ⅜ inch in diameter and 5 feet long. The gage length of 20 inches is only ⅓ the length and ½ the length is at high temperature. This slenderness gives the best possible assurance of axial loading throughout the gage length. The use of the long specimen is a frank recognition of the fact that no real long-time test can be used as an acceptance test for a particular piece of material so there is no object in hampering the test by trying to devise means to magnify the creep of a very small coupon and neither is there need to bring large shackles through the furnace packing with corresponding heat leaks, localized stresses, and uncertainty as to the true gage length.

Before inserting the specimen, special clamps are permanently attached to it at the desired gage distance apart inside the furnace. These gage clamps are made of special material with very high creep strength and in assembling the specimens they are attached so tightly that they will not come loose until creep has gone to excessively great values beyond anything of interest. In the future we propose to attach the gage rods to simple washers tack welded to the specimen. The arrangement is such that the washer shields the gage length from the

Wiring diagram for Automatic Creep Test Furnace.





3300-hour Flow Rate Test, Furnace Graph. Material annealed nickel-chromium-molybdenum steel. Item No. 609, Furnace No. T-1. Test started Nov. 15, 1932. Average test temperature 856°F. Composition: C 0.37; Mn 0.55; Si 0.16; Ni 1.78; Cr 0.77; Mo 0.36. Treatment: Annealed 825°C. and furnace cooled.

heat of the weld which is very local and entirely insignificant in the 20 inch gage length. However, this procedure is not dictated by anything unsatisfactory about the clamps, only that they are difficult to make and consequently expensive. There are two gage rods with coefficient of thermal expansion similar to that of the specimen screwed into these clamps, one in the lower clamp and the other in the upper clamp and guided by a third clamp fastened to the specimen on the outside of the furnace. With the specimen held securely at the bottom and loaded at the top, the extension upwards is a direct indication of its elongation.

With one gage clamp and measuring bar fastened at the lower gage mark, another at the upper gage mark and both running parallel to each other through the furnace wall, it is only necessary to measure accurately the difference between the ends of the rods. The dial gage used and illustrated is a standard commercial gage attached to a grooved steel block with the groove in the block and the gage spindle parallel.

It will be noted that the arrangement is independent of room temperature and that thermal expansion due to variation of temperature in the furnace is compensated for. While it is possible to argue about the accuracy of commercial dial gages, our experience in checking them leads us to conclude that any such errors are inconsequential in this application. The effect of room temperature, of thermal expansion in the furnace, and of dial inaccuracy can all be established in the interest of scientific precision, leaving no outstanding doubts on the extension.

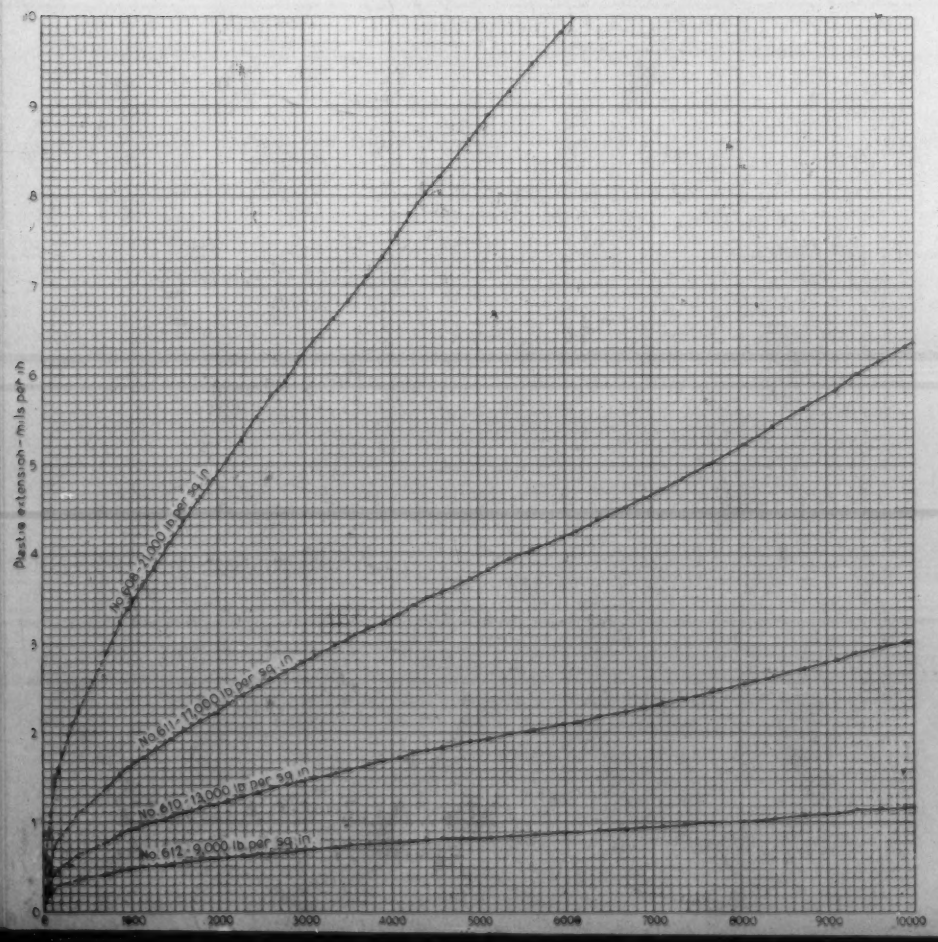
When taking readings, the gage is first checked against a standard for zero reading; it is then placed in position with the guide groove against the specimen and resting on the lower gage rod attached to the lower end of the specimen, and the spindle rests against the upper or shorter gage rod which rises as the specimen elongates. The reading on the gage directly reads the extension. As a routine check, a second reading is also taken with another gage to guard against possible error, and the zero reading is rechecked on each gage immediately after reading.

Routine readings are made to 1/10 mil (.0001 inch) in the 20 inch gage length, which is 5 parts per million of length, and the resultant curves, plotted at open scale, are surprisingly smooth. Our sentiment favors the measurement of the rather large extension over the long gage length as compared with multiplication of the small extension in a small gage length. It is likely that much of the success is due to this.

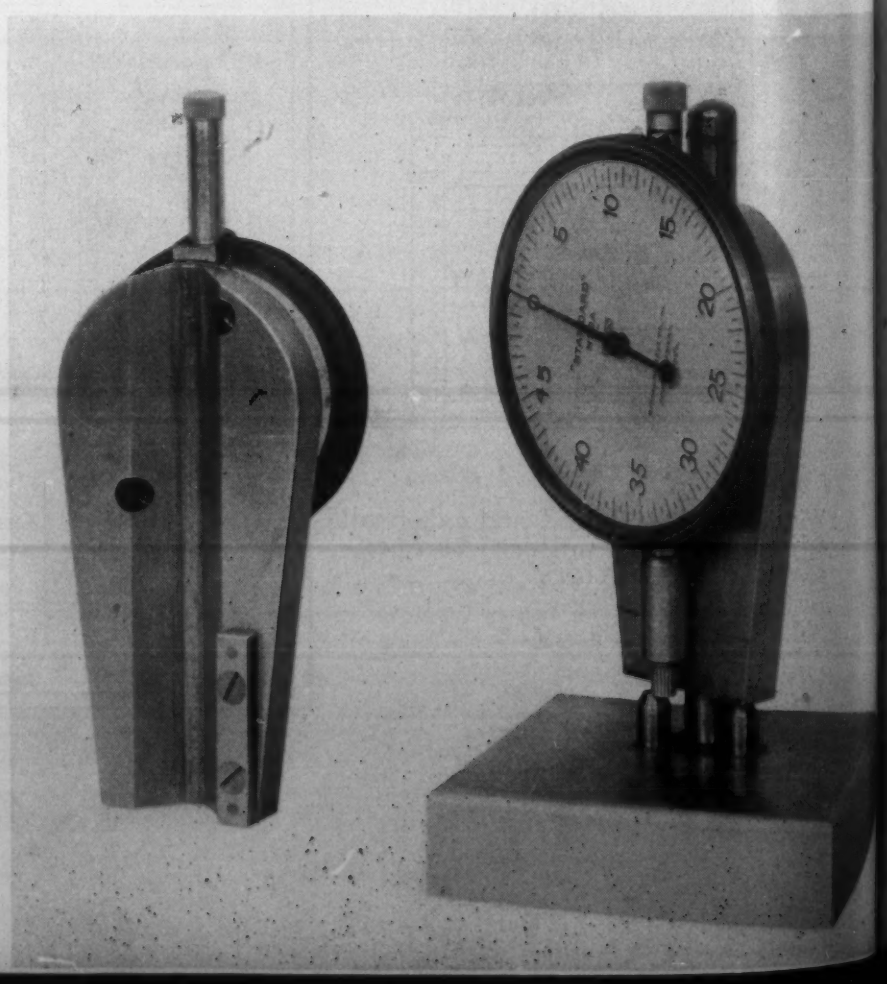
It would be entirely possible to use a mirror extensometer or a dial gage with 1/10 mil divisions which can be read to 1/100 mil or 1/2 part per million of length. Such gages are in use in older horizontal furnaces and, with special calibration, are quite reliable. However, we think such procedure would attach too great importance to short-time precision and divert attention from the more important fact that total strain and time are above all the important things and they are not at all hard to measure in a manner entirely satisfactory to engineering.

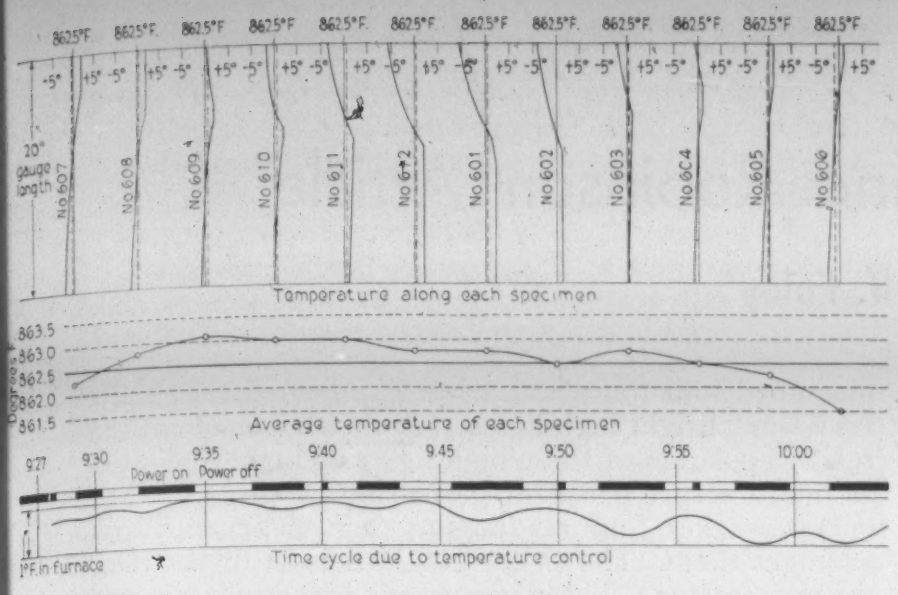
For a test of this kind, the furnace must have a very good heat distribution in order to have all specimens subjected to the same temperature conditions. It must also have close temperature control. Besides the control thermocouple, which is placed near the greatest heat supply, 9 other thermocouples have been placed throughout the compartment—3 on each end and 3 in the middle at top, center and bottom in each location. These thermocouples are wired to dummy specimens which bear exactly the same relation to the shield and heating elements as the specimens themselves and our supposition is that it is impossible for the specimen to be at a different tem-

10,000-hour Constant Stress Test, Furnace Graph. Material annealed nickel-chromium-molybdenum steel. Furnace No. T-1. Test started Nov. 15, 1932. Average test temperature 857°F. Composition and treatment: Same as shown for 300-hour flow rate test.


Plastic extension - mils per in.
No 608 - 15,000 lb per sq in
No 611 - 11,000 lb per sq in
No 610 - 13,000 lb per sq in
No 612 - 9,000 lb per sq in

Special dial gage for measuring elongation of specimens in automatic creep-test furnace.





Temperature Survey of Automatic Creep Test Furnace. Room Temperature 51°F. Such surveys ade made periodically during the actual conduct of a test by means of permanently located thermocouples. Below is shown the variation with time from moment to moment due to operation of the controls.

perature from the atmosphere in which it is located. A number of rewindings have shown that the temperature distribution can be shifted around and that it is definite for a winding. Having obtained what seemed a satisfactory distribution for these tests we have preferred to correct for it rather than to rewind again or to equip the furnace with a convection circulator. Furthermore, although the temperature level changes somewhat between summer and winter, being slightly warmer in winter than in summer, the distribution remains very much the same. We have no means of knowing at the present time how these particular thermocouples have held calibration over the time this furnace has been in operation. It is possible to remove them without disturbing the specimens but we have preferred to accept the indications observed as satisfactory for our present tests.

The temperatures are checked whenever measurements of the specimen are taken. The average temperatures of the specimens are very uniform; where one will be 3° or 4° cold on one end, it will be slightly hotter on the other—the average being about equal for all specimens. The actual temperature distribution along the specimen is graphically shown by curves "Temperatures along each specimen" and "Average temperatures of each specimen." It will be noted that Specimens Nos. 601, 602, 611 and 612 are not quite as uniform as the others. While relocating the winding might have improved this, it was not deemed necessary because the average temperatures are quite as good.

In order to be sure of our ground in this matter we have gone to the trouble to compute the actual corrections necessary to predict behavior with absolutely uniform temperature. While such corrections have to be based on approximate relations the result is so entirely negligible that the exactness of the approximate relations proved to be of no importance. It is a fact that the rate of creep changes very rapidly indeed with temperature but, on the other hand, when the temperature variation is only a few degrees the relation is so nearly linear as to render this correction a practical washout *if the average temperature is used.* This is all the more true when it is kept in mind that the change of creep rate is something like a 5 to 1 magnification of the change in creep strength.

The advantage of the long gage length in assuring accuracy of extension measurement is accompanied by the difficulty of getting even temperature distribution. There is no intention of minimizing the reality of this dilemma. However, as already explained, if not too wide, temperature variations over the gage length have compensating creep effects, but if the average temperature of the specimen is off, a correction is desirable in the creep. Our choice is for a long gage length and a liberal allowance for, with careful consideration of, temperature variation over the length. In all these matters it is necessary to keep in mind that the slope of the creep curve is an extremely sensitive index of strength or temperature variation. For instance, 1° F. may cause 1% change in strength but 5% change in slope of the creep curve.

Inasmuch as this furnace was to be located in the shop and not in the laboratory and would thus be subject to wide temperature variation from summer to winter and allowed to run for long periods without attention, extra insulation was placed on the furnace. Compared with small single-unit furnaces designed for use in a thermostatically controlled room, this apparatus has many times the heat capacity, which minimizes temperature fluctuations due to the control cycle.

Several precautions were taken in arranging the control. For instance, standard control for an electric furnace would have included but one automatic temperature control panel and temperature control instrument with thermocouple. By referring to the wiring diagram it will be noted that 2 temperature control panels and 2 temperature control instruments are used. The panels are connected in series and No. 2 instrument is set to shut down the furnace at a slightly higher temperature and not reconnect it; also, there is a mechanical shut-down device designed to shut down the furnace either on cooling or excess heat (illustrated in Fig. 1). It is mounted on one of the loading bars, and consists of a thermostatic strip to compensate for variations of room temperature, acting as an actuating finger to press another lever up or down until it makes an electric contact causing the contactor or magnetic switch of No. 2 panel to open, disconnect the power and shut down the furnace.

Ordinarily No. 1 control takes care of the furnace. If this should fail, allowing the temperature to rise, No. 2 control, or the mechanical shut-down device, will disconnect the power as soon as the temperature reaches its setting. If No. 1 control fails to close the circuit or if the furnace cools down due to any other reason, the mechanical shut-down device will also cut off the power. In either case an interlock on the magnetic switch closes, sounds a Klaxon horn and operates an indicating light in a distant office.

Any power interruption or misfunctioning of the control is similarly signaled. Thus any irregularity of operation causes the furnace to shut down and requires the presence of an observer before the test is resumed.

Across the lines beween the control panels is also connected an electric clock, which is not self-starting, and an electric time meter. The time meter registers the hours the furnace is in operation. The time meter and clock are on opposite sides of No. 2 control, an arrangement which gives information as to whether a shut-down was due to causes within or outside of the apparatus.

Heating and cooling curves were taken on this furnace. These are useful for determining the effective length of a shut-down, which is highly necessary for short-time testing.

Even under the best conditions, tests intended to cover many months or a period of years, must be prepared for such interruptions. Ample experience shows that the furnace may go completely cold, provided the loading is undisturbed, and on resumption of temperature, there will be no break in the creep curve at all.

From the above one can readily see that many safeguards have been set up to insure reliable results.

When the furnace was designed, the heating units were designed for a connected load of 6 kw. maximum. When the furnace was finally put into operation, some adjustments were necessary for improving the heat distribution. Rheostats were placed in each circuit for adjusting the power input to as nearly radiation losses as possible, taking into consideration that this will change from summer to winter because of the changing room temperature for warm and cool days. The connected load in the furnace became 4.75 kw. and the actual consumption is approximately 2.4 kw.

The variation in temperature due to the control is illustrated. Referring to the chart, it will be seen that the maximum temperature difference in the specimen is less than 1° F. and that the power is on approximately 55% of the time with a connected load of 4.75 kw.

The curve showing a 3300 hour flow rate test with limited extension shows the smoothness of observations under ordinary conditions of furnace operation.

The long time performance of this furnace is illustrated by the curves showing the results of a 10,000 hour constant stress test. Such tests are necessary because below 1000° F. materials rarely attain a straight line creep curve.

During the 10,000 hours represented by these curves the temperature of the shop in which this furnace was located varied from 45.5° F. in winter to 93.0° F. in summer. In spite of this the fluctuations of temperature in the specimens did not exceed +6.6° F. which occurred in winter and —8.0° F. which occurred in summer. For 80% of the time the fluctuation was within +3.0° F. and —4.0 F. While the results presented herewith are uncorrected for such fluctuations, the required corrections are well known and have been applied for our own records.

This furnace has been designed especially so as to render possible good tests of 10,000 hours duration or longer under ordinary shop conditions without the expense of laboratory supervision.

However, it is equally well adapted to short time tests of 1,000 hours or a few weeks. Two years of experience in comparison with furnaces under daily supervision has shown that the expense of operation is not more than about 1/10 as much as for furnaces with more delicate controls, the exact expense depending upon the number of furnaces that can be supervised by a single operator.

Discussion of Clark and Robinson Article

By Francis B. Foley*

The furnace described by Clark and Robinson for creep testing at the General Electric Company's plant and the long-time-test results obtained from it are very interesting. They are particularly interesting to me because the furnace, the method of measuring extensions and the specimen used all differ widely from those in our laboratory at Midvale. At Midvale, the specimens are each in separate furnaces, each under its own control system. The specimen has a 2-inch gauge length and is of the shape of the usual standard 0.505-inch diameter test specimen and measurements are made on reference points attached to the specimens themselves. Each furnace is checked during construction for temperature distribution with a specimen in place and alterations are made in order to bring every furnace used to uniformity of temperature distribution along the specimen to within the order of 2° F. for the temperature range up to 1400° F. The temperature of each furnace is controlled by means of a thermocouple with its hot junction close to the furnace winding so as to anticipate temperature fluctuations and correct for them before the temperature of the specimen itself has been affected in a measurable degree.

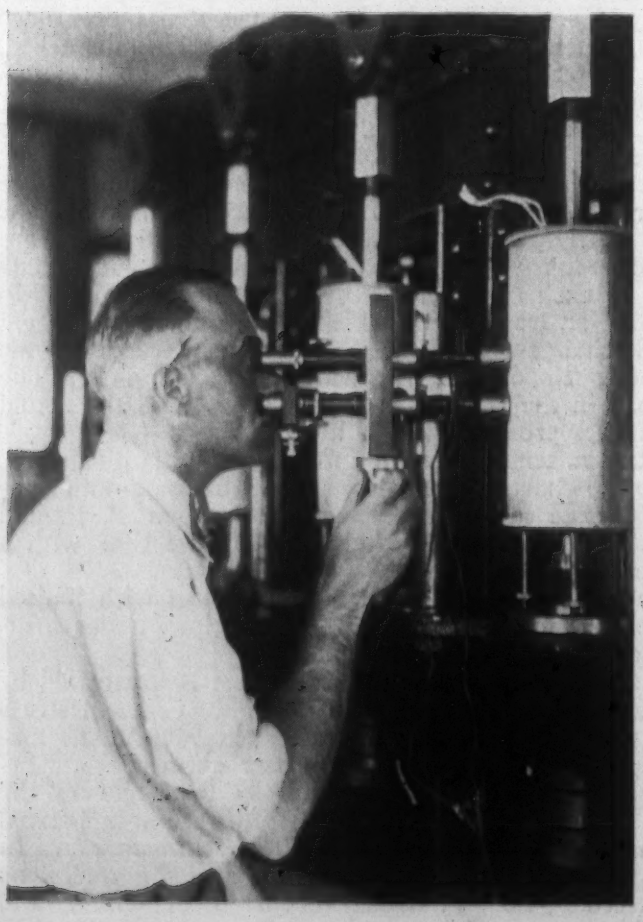


Fig. 1.—General Idea of the Midvale Furnace and the Method of Reading.

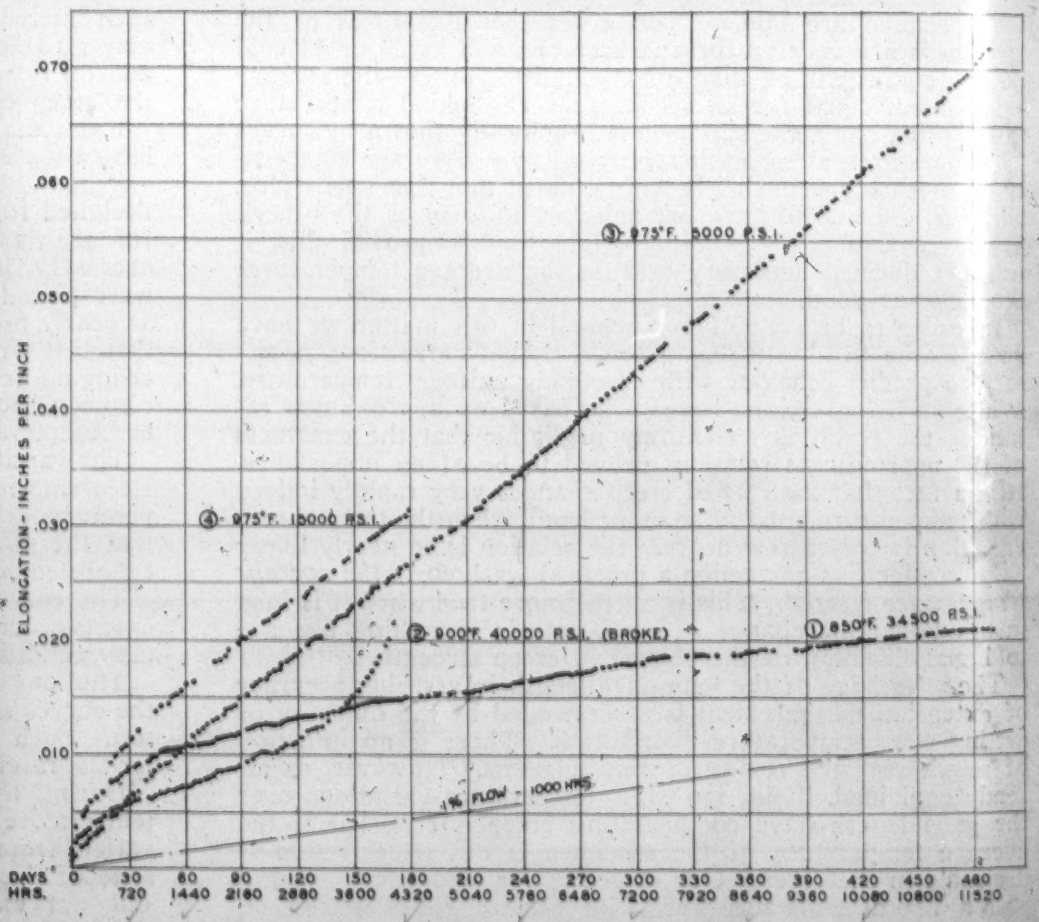


Fig. 2.—Plotting of Points Obtained from Form Specimens, Two of Which Had Been under Load at Elevated Temperatures for 16 Months.

Measurements of extension are made through quartz-glass windows by means of a double telescope, one tube having a Filar eyepiece with micrometer adjustment, sighted on two reference points fixed approximately two inches apart on the specimen. A lamp at the end of the telescope throws a light into the furnace. The reference points, consisting of fine platinum wire, are magnified four times and, when illuminated, they show very small bright high lights. A sketch is made of the relative position of these high lights and one is selected as the reference point for measuring extensions. The operator takes four readings at each observation and averages them. The figure obtained is in divisions of the micrometer. These figures are converted to inches per inch and plotted by another individual so that the reader is free of the tendency to anticipate his results. It is felt that readings made directly on the specimen are not subject to the possibility of mechanical errors introduced by some other systems, nor to errors introduced by room temperature fluctuations. Fig. 1 gives a general idea of the furnace and method of reading. The measuring instrument makes possible readings of 0.00002 over the 2-in. gauge length.

A plotting of points obtained from four specimens, two of which have been under load at elevated temperature for 11,500-hr. (16 months) is shown in Fig. 2. The four curves represent four different analyses of low alloy, low carbon pearlitic steels. No line has been drawn through the points and it is noted that, although the methods of conducting the test have been quite different from that used by the General Electric Company, these Midvale curves show the same wavy character which appear in the curves presented by Clark and Robinson. In plotting the Midvale results the time scale is condensed, each horizontal division representing a month. There seems to be two periods to the waves, one of a month or two and the other covering a time of the order of six months. The waves in the curves, when plotted to our normal time scale which

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produces a curve about four feet long, escape attention but, after condensing the time scale and attempting to draw a smooth curve through all the points, one is led to question the meaning of the undulations.

I am not inclined to believe these waves are the result of experimental error. They are too persistent and have a certain regularity, particularly in Curve 1 at 850° F. They are regular enough to cause one to suggest that, had one been looking for them during testing and studying the phenomenon, a definite period might have been established for them.

Tentatively, I have arrived at the following explanation: It is well known that crystal growth occurs below the critical temperature of metals which have been cold worked, the temperature for critical grain growth depending on the degree of cold working. The greater the amount of cold working, the lower the temperature required for recrystallization. A common method of showing this phenomenon is to produce varying degrees of permanent strain in the metal and then to heat to some temperature, cool and etch. A sectioned tensile test bar or a section through a Brinell impression will show it very well. This process is simulated in creep testing, the temperature being kept constant and deformation increasing gradually if the load be high enough. When the deformation has built up to a critical amount, recrystallization will occur and the newly formed crystals then undergo deformation over a period of time until they in turn have attained the necessary critical degree of strain, when recrystallization occurs again. There may be a relatively rapid repetition of this phenomenon due to local deformation and at the same time a slower building up of strain and a more gradual crystallization en masse which might account for curves having waves of relatively short length superimposed upon a much longer one. In any event, the period and amplitude of the undulations will depend on the load and temperature of testing. Such curves of course would be expected only at temperatures under which cold working and recrystallization may occur. At temperatures high enough to anneal out spontaneously the smallest amount of strain produced by the load, smooth curves should result. At temperatures too low for recrystallization to keep up with cold working, embrittlement and sudden failure might be expected ultimately to occur.

In addition to this combination of straining and recrystallizing, there probably also occurs varying degrees of crystalline slip. Conceivably, certain planes favorably oriented with respect to the load accommodate themselves by yielding a certain amount so that they become more resistant to further slip. Strain is then transferred to a new series of planes. This process might also be expected to produce undulations.

In testing in the "strain-hardening" range of temperature, we have noted in many cases that specimens showing an almost unmeasurable rate of increase of deformation over a thousand or two thousand hours, may then undergo a sudden, though small, increase in rate over a very short period of time, resume a constant very low rate of increase in deformation for another long period, and then again show a sudden jump. This may be due to the same cause that produces wavy curves.

Much attention is given abroad, particularly in Germany, to short-time methods of determining deformation to be expected over long periods of time. These methods usually fix a rate of flow which is not to be exceeded during a period of time early in the test. The load producing this rate of flow is taken as the limit of viscosity. Were such a method trustworthy it would most certainly be welcome.

According to Körber, (*Revue de Metallurgie*, August, 1934,) the Kaiser Wilhelm Institute für Eisenforschung has concluded that a steel showing a limit of 0.005% hr. rate of flow between the third and sixth hours will show 0.003%/hr. between the fifth and tenth hours, 0.0015%/hr. between the twenty-fifth and thirty-fifth hours, and will finally settle down in finite time to approximately zero rate of flow. This short method is used up to 500° C (932° F.). The long-time curves herewith do not appear to bear out such a conclusion. The early behavior of Curve 3 indicates a much lower rate of creep than that of Curve 1, yet in Curve 1 the rate decreased continuously over the 11,500 hr. of test and may become zero in time, whereas Curve 3 indicates the steel must ultimately fail. Curve 2 shows a steel which failed although, were one guided by the early hours of test, it might have been expected to show ultimately an even lower rate than Curve 1.

"Magnetic Materials" by W. C. Ellis and Earle E. Schumacher

Additional Bibliography

In the January issue of METALS & ALLOYS, pages 26 to 29, there appeared the second and concluding installment of an article, "Magnetic Materials, A Survey in Relation to Structure" by W. C. Ellis and Earle E. Schumacher. The first installment was published in December. Unfortunately the portion of the bibliography which should have accompanied the second portion of the article was omitted. This is supplied herewith as follows, supplementing the other portion published in January:

[28]R. L. Sanford. "Some Principles Governing the Choice and Utilization of Permanent Magnet Steels." *Scientific Paper, No. 567, Bureau of Standards*, Vol. 22, 1927, page 557.

J. A. Mathews. "Retained Austenite—A Contribution to the Metallurgy of Magnetism." *Transactions*, American Society for Steel Treating, Vol. 8, 1925, page 565.

[29]K. Honda and S. Saito. "On K.S. Magnet Steel." *Physical Review*, Vol. 16, Part II, 1920, page 495.

[30]T. Mishima. "Magnetic Properties of Iron-Nickel-Aluminum Alloys." *Ohm* (coversheet) July, 1932; *The Iron Age* (abstract), Sept. 1932, page 346.

French Patent No. 731,361.

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W. Köster. "Das System Eisen-Nickel-Aluminum." *Archiv für das Eisenhüttenwesen*, Vol. 7, 1933, page 257.

W. Steinhaus and A. Kussmann. "Neuere Entwicklung der Dauermagnetstähle." *Physikalische Zeitschrift*, Vol. 35, 1934, page 377.

"Nickel-Aluminum Magnetstahl." *Archiv für technisches Messen*, Vol. 3, 1934, page T56.

[31]K. S. Seljesater and B. A. Rogers. "Magnetic and Mechanical Hardness of Dispersion Hardened Iron Alloys." *Transactions*, American Society for Steel Treating, Vol. 19, 1932, page 553.

W. Köster. "Über die Beziehungen der magnetischen Eigenschaften, insbesondere der Koerzitivkraft zum Gefügeaufbau der Legierungen und die Entwicklung neuartiger Magnetlegierungen." *Zeitschrift für Elektrochemie und Angewandte Physikalische Chemie*, Vol. 38, 1932, page 549.

W. Köster. "Dauermagnetiwerkstoffe auf der Grundlage der Ausscheidungshärtung." *Stahl und Eisen*, Vol. 53, 1933, page 849.

[32]Y. Kato and I. Tokei. "Permanent Oxide Magnet and Its Characteristics." *Journal of the Institute of Electrical Engineers of Japan*, Vol. 53, 1933, page 408.

A Portable Babbitt Pot

By H. K. Sellick

Inspection Dept., Westinghouse Electric & Manufacturing Co., Mansfield, Ohio.

WHEN BABBITT BEARING LININGS on heavy machinery require relining, it would often be more convenient to re-babbitt the bearing in place, right at the machine, than to dismantle it and take the bearing to the babbitt shop. When the old-time babbitt-melting

Fig. 1

furnace, shown in Fig. 1, is used, the bearing must, of course, go to the furnace.

One large plant with machinery, that from time to time must have its bearings repaired, scattered all over a large plant, decided to remedy this situation; so the portable electric furnace shown in Fig. 2 was devised. An electric melting pot of 500-lb. capacity, with the control panel and thermostat, was mounted on a truck and sufficient cable provided so that power lines can be reached from any machine in the plant.

An automatic time clock is provided so that the power may be turned on at night and the babbitt be ready to pour when the workman comes on the job in the morning. The thermostat is both indicating and controlling and can be

Fig. 2

set to heat the metal to the proper temperature for pouring.

For use on smaller bearings where the bearing can be brought to the furnace, the pots shown in Fig. 3 are provided. These are 150-lb. pots, 4.5 k.w., 220 volts, single-phase, and are also provided with the indicating-controlling thermostat. There is considerable space-saving over the outfit shown in Fig. 1, as well as much better working conditions. Thermostatic control is more simply applied

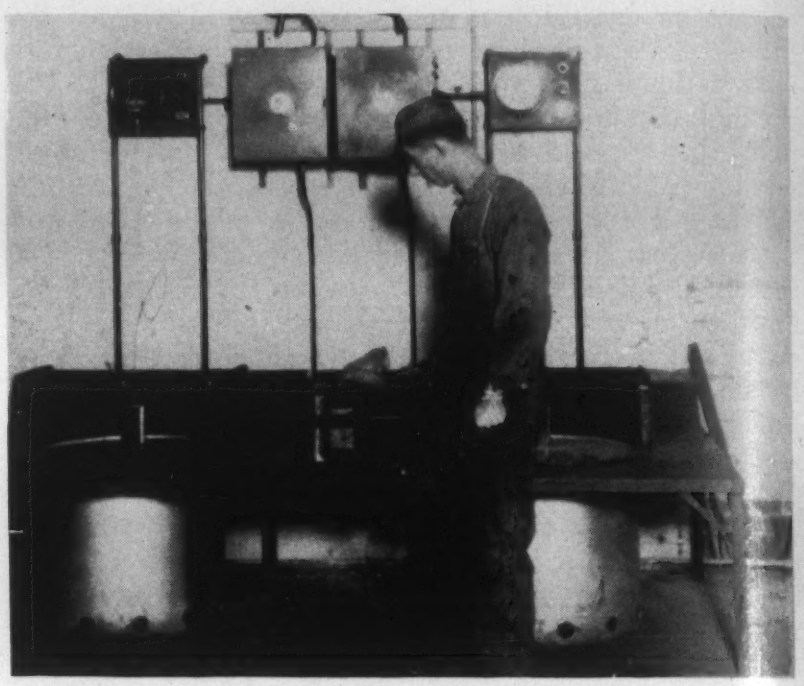

Fig. 3

to the electric pot than to fuel-fired pots, and this is, of course, highly advantageous for the production of babbitt linings of high and uniform quality.

The pot heats up to 800 deg. F. in 1½ hr. from a cold

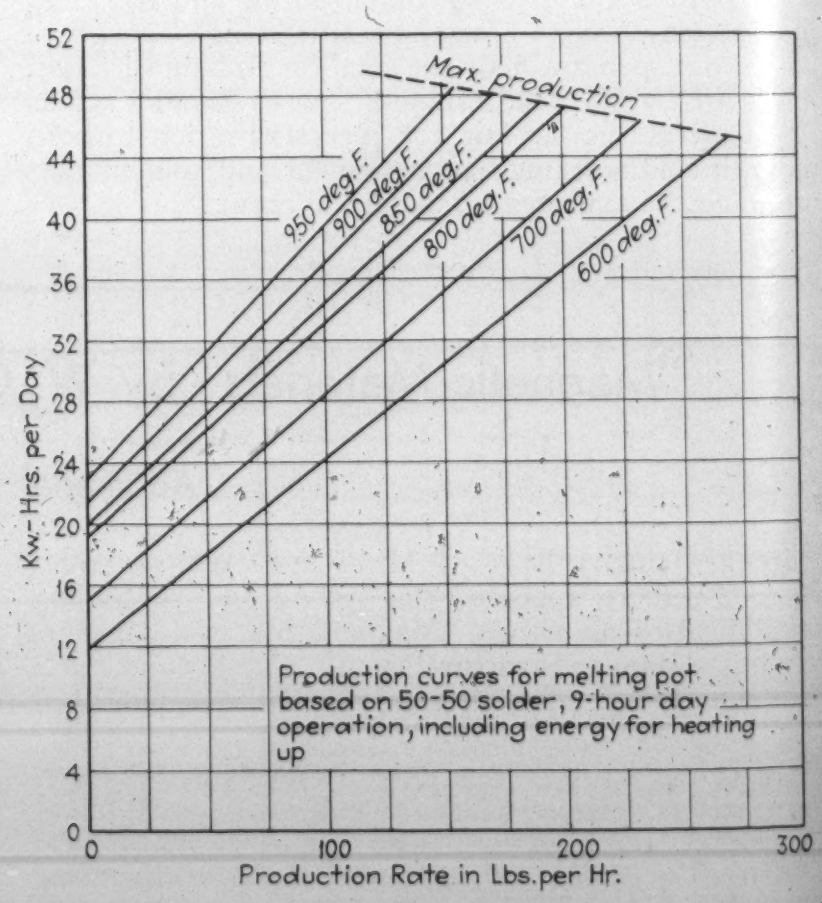

Fig. 4

start. Production curves (determined on 50:50 solder) are shown in Fig. 4. Beside the well-known advantages of electric heat, it has been found that cracked pots occur less frequently with electric heating than with fuel heating.

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

Ore Concentration in the Past and its Present Problems (Anrikningen under gaangna tider och dess aktuella spörsmaal). STURE MÖRTSELL. *Bergshandteringens Vänner*, Vol. 21, Jan. 1934, pages 185-206; with discussion, pages 207-232. A brief historic review of old concentration processes. Discusses the development of magnetic separation of iron ores, particularly as practised in Sweden. Presents a schematic explanation of the flotation process, and of the action of the different flotation reagents. Grinding methods are reviewed. Application of flotation to various types of Swedish ores, including oxide ores and nonmetallic minerals is given. Recent flow sheets of Swedish magnetic concentrating plants, results from flotation experiments on iron ores, and calculations of recoveries are presented in the discussion. BHS (1)

Experimental Tests on Gold Ore from the Sullivan Consolidated Mines, Limited, Dubuisson Township, Abitibi County, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 195-204. The ore contained Au 0.285 oz. and Ag 0.095 oz./ton. Amalgamation of —48 mesh material recovers 49% of the Au; cyanidation of the tailings raises recovery to 95%. Straight cyanidation at —200 mesh gives 96% extraction. The amalgamation tails can be concentrated by flotation and the concentrate cyanided. Excess of lime retards solution of Au. AHE (1)

Exploitation of Gold Bearing Ores at Kilo-Moto (Les méthodes d'exploitation des minerais aurifères de Kilo-Moto). CH. BERTHELOT. *Revue de Métallurgie*, Vol. 31, Aug. 1934, pages 333-358, Sept. 1934, pages 396-408. Detailed description of grinding, amalgamating and flotation installations amply illustrated with the production data. JDG (1)

Ore Dressing. CHARLES E. LOCKE. *Mining & Metallurgy*, Vol. 15, Jan. 1934, pages 27-29. Reviews progress in 1933. VSP (1)

Experimental Tests on Gold Ore from Gold Rand Mineral Claim, near Sanca, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 16-19. A highly oxidized ore assaying Au 0.48 oz. and Ag 4.84 oz./ton and Fe 28.0, Pb 0.91, Zn 0.05, Cu 0.35, and insoluble 30.05% was concentrated by tabling, flotation, amalgamation and cyanidation. All were satisfactory. AHE (1)

Trends in Practice and Costs of Concentrating Copper Ores. T. G. CHAPMAN. *United States Bureau of Mines Information Circular* No. 6792, Sept. 1934, 45 pages. General developments in concentrating Cu ores are traced from 1912 to 1932, including the introduction and development of flotation, the trends in Cu content of heads, recoveries, and costs. Present methods of concentrating Cu ore are described and flow sheets are given. Costs for 16 mills are tabulated. AHE (1)

The Latest Development in Mass Production Concentrators. S. DAWSON-WARE. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, Sept.-Oct. 1934, pages 314-315. AHE (1)

Gold Ore from the Sullivan Consolidated Mines, Limited, Dubuisson Township, Abitibi County, Quebec. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 77-80. Au recovery by amalgamation was 72%. Plates recovered 50% of the Au, flotation of the tailings gave 82% recovery; cyanidation of the concentrate extracted 97% of the contained Au; overall recovery was 94%. AHE (1)

Recovering the Gold from California Ores. *Engineering & Mining Journal*, Vol. 135, Nov. 1934, pages 503-505. Recovery of Au from California ores ranges from single washing and gravimetric separation of alluvial materials to the treatment of lode ores by amalgamation, concentration, cyaniding and flotation. The stamp mill is disappearing. Automatic sampling affords closer control over milling operations. WHB (1)

Low-Grade Gold Ore from the Young-Davidson Property, Matachewan, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 81-100. From 88.3 to 91.6% of the Au in an ore analyzing Au 0.11 oz., Ag 0.058 oz./ton, Fe 2.53%, S 1.60%, and Cu 0.01% is recovered by blankets, or trap, or amalgamation followed by flotation and cyanidation of the concentration in large-scale tests. AHE (1)

1a. Crushing, Grinding & Plant Handling

Screening — Vibrating Screen Practice II. J. G. TURVEY. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, Sept.-Oct. 1934, pages 299-302. Stratification and various practical considerations of vibrating screen design and operation are discussed. AHE (1a)

1b. Gravity Concentration

Recent Investigations on Gold Ore Dressing by Means of Flotation (Neuere Untersuchungen über Golderzaufbereitung durch Flotation). W. PETERSEN. *Die Metallbörse*, Vol. 24, Sept. 8, 1934, pages 1145-1146. Based on recent findings of Oldright & Head, Jackson & Knaehel, and Leaver, Wood & Head, microscopic investigation on crushed Au ore, utilization of flotation for Au ores, flotation of refractory Au ores, effect of particle size on flotation ability, and nature and occurrence of Au in pyrite are discussed. EF (1c)

Experimental Tests on a Shipment of Gold-Silver-Copper-Lead-Zinc Ore from Teddy Glacier Mine at Cambourne, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 211-212. The ore averaged Au 0.66 oz., Ag 9.78 oz./ton, Cu 1.07, Pb 15.54, Zn 23.00, Fe 16.64, S 29.90 and insoluble 11.10%. The ore concentrates readily by flotation. AHE (1c)

Tests on Gold Ore from White Water, Taku River Area, British Columbia. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 170-171. The ore is not amenable to amalgamation or cyanidation. It can be concentrated in a product suitable for shipment to a smelter with 75-80% recovery of Au. AHE (1c)

Experimental Tests on Two Samples of Gold Ore from Beaufor Gold Mines, Limited, Pascalis Township, Northwestern Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 185-195. Straight cyanidation yields excellent recoveries. Approximately 75% of the Au is recovered by amalgamation. Recommended practice is to amalgamate, float tailings, regrind the concentrate and cyanide. AHE (1c)

Gold Ore from the Beattie Gold Mines, Limited, Duparquet Township, Abitibi County, Quebec. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 41-62. Extensive tests were made on an ore containing native Au, pyrite and arsenopyrite disseminated in a quartz-carbonate gangue. A 2-3-oz. concentrate and a 0.02-oz. tailing can be obtained by flotation according to a flow sheet outlined. Tests were made in a continuous pilot plant. AHE (1c)

Gold-Silver Ore from Dentonia Mines Syndicate, Greenwood, British Columbia. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 101-106. More than 90% of the Au, Ag and Cu from a sample assaying Au 0.73 oz., Ag 4.18 oz./ton, Cu 0.15%, Pb 0.37% and Zn trace can be obtained by flotation, amalgamation and flotation, or blanketing and flotation; the concentrate will assay 10 oz. Au and 60 oz. Ag/ton. Tailings are high due to limonite coatings. AHE (1c)

1d. Magnetic Separation

Variability in Artificial Ferromagnetic Iron Oxides. LARS A. WELO & OSKAR BAUDISCH. *American Journal of Science*, 5th Series, Vol. 28, Aug. 1934, pages 139-149. There are no major differences between the magnetic properties of magnetites and those of ferromagnetic ferric oxides. The effect of impurities is minor. A high temperature at some time during formation yields a material magnetically hard. The effect of oxidizing magnetite is to soften the material. The Cu ferrites are extremely soft since the lattice is strained because the Cu ions are larger than the ferrous ions; the ferrite with the most Cu is softest. The remanences group around 3 main values: 1.90; oxides derived by dehydration of gamma ferric oxide hydrate, 11.0; the balance, 14.5-17. AHE (1d)

1e. Amalgamation, Cyanidation & Leaching

Hydrometallurgy of Copper Sulphide Ores and Its Relation to Mineral Structure. W. A. SLOAN & C. W. DAVIS. *Progress Reports—Metallurgical Division. 3. Studies in the Metallurgy of Copper. United States Bureau of Mines, Report of Investigations* No. 3228, May 1934, pages 53-56.—There is no practical hydrometallurgical process in which Cu is removed completely from all its sulphide minerals by direct lixiviation. Pretreatment with salt solutions has proved efficacious for some minerals, but no decided increase in Cu extraction from chalcocite, covellite, chalcopyrite or bornite by acid—$Fe_2(SO_4)_3$ solutions was obtained by pretreatment with solutions of sulphates of Cu, Zn, Ni or Al or with $NaNO_3$. Cu sulphides may be converted to water-soluble sulphates by heating with a definite amount of O_2 or air and by adding H_2SO_4 to a mixture of the mineral with MnO_2. Conversion to chlorides may be effected by treatment with Cl_2, the action at room temperature being accelerated by adding HCl to a mixture of the sulphide mineral with MnO_2. Arsenious acid, Na arsenate, Na arsenite, NaF, NH_4 vanadate, vanadic acid, persulphuric acid, charcoal, cresol, pyrogallic acid, tannic acid, sugar, dextrine and starch did not accelerate the dissolution of Cu from chalcocite, chalcopyrite, covellite and bornite in H_2SO_4—$Fe_2(SO_4)_3$. $KMnO_4$ and $K_2Cr_2O_7$ increased Cu dissolved, but the highest extraction with -100 mesh samples at room temperatures in 24 hours was less than 50%. Heating raised extraction from all but chalcopyrite. An aqueous solution of 1.75% ICl_3 + 0.003% H_2SO_4 was a powerful solvent for Cu sulphide minerals (69% of chalcopyrite, more than 98% of all others). S_2Cl_2 in presence of H_2O, dilute H_2SO_4 or acid-$Fe_2(SO_4)_3$ solution markedly accelerated dissolution (up to 72% chalcopyrite, more than 98% for all others). Fine chalcopyrite (-270 mesh) treated with dry Cl_2 at 50° yielded 96.4% of its Cu (water-soluble). The resulting product contains Cu and Fe in different states of oxidation. About 90% of the water-soluble Cu is Cu_2Cl_2, while 85% of the water-soluble Fe is $FeCl_3$. If Cu sulphide minerals are constituted in such a way that S or some group of elements insoluble in dilute Cu solvent is so placed in the crystal lattice that the surface is protected by it, the rate of solution of the contained Cu would be controlled by certain resistance limits specific in each mineral. An accelerator might dissolve the protective coat. AHE (1e)

Tests on Gold Ore from the Highland Enterprise Company, Barren Lake, Manitoba. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 138-143. Amalgamation of —48 mesh ore containing Au 0.68 oz., Ag 0.16 oz./ton and As 0.17% recovered 82% of the Au. Amalgamation of —100 mesh ore followed by cyanidation gave 98.5% recovery. Straight cyanidation of —200 mesh ore yielded 99.3% of the values. Flotation alone was not efficient. Amalgamation and flotation gave 97% recovery. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

2a. Non-Ferrous

Melting of Copper Waste at Moscow Molotov Works. G. A. Shakhov. *Tzvetnuie Metallui*, No. 5, June 1933, pages 37-51. Describes test melts made for the purpose of recovering Cu from scrap, waste metal, Cu-bearing refuse, etc. BND (2a)

Precipitation of Copper Under Pressure by Means of Organic Reducing Agents. V. I. Layner, E. V. Natanson & A. A. Orionov. *Tzvetnuie Metallui*, No. 6, Aug. 1933, pages 87-102. The authors investigated the extraction of Cu from its solutions by reduction with cellulose-containing substances (wood saw-dust) under high pressure. From acid solutions of $CuSO_4$ and from commercial solutions obtained by leaching Cu ores 80-85% extraction of Cu was obtained at 6 — 8 atm. and 160°-170° C. The Cu can be separated from the solution on concentrating tables, or it can be filtered out and remelted. In the absence of agitation the recovery increased with pressure; with agitation good recovery probably could be obtained at lower pressures (4-5 atm.). The optimum duration of the reduction is 4 hrs. The presence of Fe, Al and other electro-negative metals does not interfere. Extraction is practically independent of the Cu concentration of the solution. The autoclave solutions after extraction of the Cu can be used again for leaching, because the H_2SO_4 is regenerated. The method can be applied successfully to the extraction of Ag and Hg. The chemistry of the process was investigated and the following conclusions made: The process is analogous to the reduction of metals by hydrogen under similar conditions. The reduction of Cu is effected by the products of hydrolysis of cellulose, namely, the aldehyde group of sugars and HCOOH. The cost of production of Cu by the autoclave method is estimated to be lower than by electrolytic extraction. BND (2a)

Electrothermic Extraction of Magnesium Metal (Die elektrothermische Gewinnung von Magnesium-Metall). F. Hansgirg. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 109-112. Mg is extracted by electrolysis of its fused halogen compounds. The history of reduction processes is outlined briefly and equipment is described. The process used in the Radenthein plant is described; MgO is reduced with coal ($MgO + C \leftrightarrows Mg + CO$) at 2200°-2300° C. Mg, purity 99.97-99.98%, is condensed. The cost is said to be low; the energy consumption is not more than 24-25 kw. hr./kg. metal in bars. Ha (2a)

2b. Ferrous

Solubility of Sulphur in Blast Furnace Slags in Connection with their Composition and Degree of Overheating. N. R. Rulla & B. A. Hess. *Domez*, No. 8, 1934, pages 23-34. In Russian. Study of 250 samples of blast furnace slags taken in South Russian plants showed that desulphurization depends directly on CaO content, which should be as high as possible. When MgO is introduced it should replace SiO_2 or Al_2O_3 but not CaO. With the same CaO content, S in slags increases with the temperature. Laboratory experiments consisted in melting 80 g. of cast Fe with 0.7 of its amount of slag (S 2.256 g.) at 1350°, 1450°, 1550° and 1600°C. S content of slags increases with the temperature. FeO decreases S content. MgO has the worst effect in the range 4 to 6.8%; lower MgO leads to greater S solubility. Al_2O_3 does not absorb S. Slags with 9.7-10.5% Al_2O_3 and 5-7% MgO had the least S solubility. Increasing MgO to 8-9% with the same Al_2O_3 content assures S solubility of 3% at 1450°-1600°C. with slags having an acidity of 0.72, and at 1350°C. with slags having an acidity of 0.71. MgO must be kept below 4.5% when a high S content is desired in slags with 16-18% Al_2O_3 and acidity of 0.64-0.72 and in the range 1350°-1600°C. In the interval 46-50% each % of CaO corresponds to 0.1% S in the slag. In basic slags ($SiO_2/CaO = 0.45$) increase of MgO between 3 to 7% raises S solubility, in acid slags ($SiO_2/CaO = 0.70$) S solubility decreases with increasing MgO. With 9-10% MgO and 55-60% CaO only 2% S is dissolved. Up to 3.2-3.5% MnO increases S solubility, above it decreases. (2b)

Distribution of the Materials in Blast Furnaces on Charging but Before Blowing Them in. M. B. Posin. *Domez*, No. 8, 1934, pages 14-23. In Russian. Distribution of materials charged into 6 blast furnaces with different charging apparatus was determined. The ridge of the charge surface moves toward the walls on the lower levels and toward the center in the upper levels of the furnace. The height of the ridge of the charge level depends on the opening between the charging bell and the walls of the furnace. (2b)

3. MELTING, REFINING AND CASTING

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Purification of Metals by Volatilizing in a High Vacuum. Chromium, Aluminum, Silicon, Beryllium (Die Raffination von Metallen durch Verdampfen im Hochvakuum, Chrom, Aluminium, Silizium, Beryllium). W. Kroll. *Metallwirtschaft*, Vol. 13, Oct. 19, 1934, pages 725-731. The metals were melted in a high frequency induction furnace under high vacuum, distilled and condensed. The starting materials, distillates and residues were analyzed chemically and spectrographically. The separation of Al, Fe, and Si from Cr is not sharp. Part of the Si remains in the residue. Cr which has been distilled and remelted under Ar has a Brinell hardness of 120. The separation of impurities from Al is very complete. Mn distills in the first fraction, while Si, Fe, Cu and Ti concentrate in the residue. Gas evolution and sputtering make the distillation of Al difficult. Because of oxide formation on the colloidal condensed particles it is impossible to remelt even under Ar except with a flux. Al can be obtained of greater purity than by the Hoopes process. Si must be preheated to 1000° C. before it can be melted in the induction furnace. If the Si contains SiO_2, a large amount of it distills with the Si. The higher melting metals, especially Fe, concentrate in the residue. Si also evolves gas. Be can be distilled without difficulty. The separation from carbides, oxides, nitrides, Fe, Ni, and Cr, which remain, and from the alkalies, alkaline earths and Pb, which distill in the first fraction, is very complete. It is less complete from Cu and Si, and poor from Al and Mn. Distilled Be, remelted under Ar, poured in air and reheated under Ar, can be only slightly hot worked. It has a Brinell hardness of 120 to 130. The separation of metals by distillation depends not only on the partial pressures of the individual components, but also on the formation of solutions and compounds, especially if the impurities are high. CEM (3)

New Ways in Sweep Molding (Neue Wege in der Schablonenformerei). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Sept. 16, 1934, pages 381-382. Paper first discusses difficulties and inaccuracies occurring in sweep molding. A sweep molding apparatus with support sweep arm is then described. This new molding device is further equipped with a special arrangement for automatically lowering the sweep. The apparatus described is manufactured by Freitag Co., Olpe, Westfalia. GN (3)

Blast-Furnace Tuyeres. *Foundry Trade Journal*, Vol. 50, Mar. 8, 1934, page 169. Note illustrated by 1 diagram, dealing with molding details for a blast-furnace tuyere. OWE (3)

Recommended Methods for Testing and Control of Foundry Molding Sands. *Special Publication No. 2 of the British Cast Iron Research Association*, Apr. 1934, pages 1-54. Methods and instruments for testing molding sands are reviewed; the advantage of carrying out both strength and permeability tests on one test piece in a standard double compression core box is recommended. The report deals with sampling, determination of moisture, mechanical properties and chemical composition. Ha (3)

The Development of Induction Melting and Heat Treating. E. F. Cone. *Industrial Heating*, Oct. 1934, pages 55-58. Progress of use of electric heat in metallurgical melting processes and in heat-treating operations is reviewed, statistics on steel and alloy steel produced in this manner and on electric furnaces, in particular induction furnaces are given. Advantages of high-frequency induction furnaces are pointed out. Ha (3)

Specializes in Small Castings. Pat Dwyer. *Foundry*, Vol. 62, Feb. 1934, pages 16-18, 58. High surface finish is essential on all castings and therefore sand is selected and controlled carefully. Moisture is held to a minimum, 4.5 to 5% for light castings and 5 to 5.5% for others. Discusses method of casting and handling of products. VSP (3)

BETTER CASTINGS

Falls Brand Products

Aluminum and Alloys

99% Plus Aluminum
98-99% Aluminum
94-98% Aluminum
No. 12 Aluminum Alloy
No. 31 Aluminum Alloy
S.A.E. Aluminum Alloys
Falls Special Pattern Aluminum
Falls Tensile Aluminum (30,000 lbs.)
Falls Aluminum Solder

Intermediate Alloys

Nickel Copper	50-50*
Silicon Aluminum	50-50
Copper Aluminum	50-50
Nickel Aluminum	20-80
Manganese Aluminum	25-75
Ferro Aluminum	20-80
Nickel Tin	50-50*
Ferro Nickel	50-50*

*SHOT FORM

Fluxing Alloys

Phosphor Copper, 10 and 15% P*
Silicon Copper, 5 to 50% Si.
Manganese Copper, 30% Mn. Grade A
Manganese Copper, 25%-30 Mn. Grade B
Magnesium Copper, 20% Mg.

Special Alloys

Falls No. 14 Alloy* (For pressure tight castings)
Falls No. 55 Alloy* (Deoxidizer and Densifier)
Falls No. 21 Alloy (Manganese Bronze Hardener)
Falls No. 11 High Electrical Conductivity Alloy
Falls No. 26 Aluminum Bronze Deoxidizer
N. F. Nickel Shot* (For grey iron)
Ferro Deoxidizer (For grey iron)
4-11-44 Alloy* (For grey iron)
Falls No. 15 Alloy (Nickel Deoxidizer)
Cataract Metal

Hardeners

Manganese Bronze Hardener
Aluminum Bronze Hardeners

Nickel Copper Aluminum	20-40-40
Nickel Copper Aluminum	25-25-50
Silicon Copper Aluminum	25-25-50
Copper Iron Aluminum	25-25-50

Hardeners to any Specifications

A Monthly Message From

NIAGARA FALLS SMELTING & REFINING CO.

Beginning with the next issue, a monthly message on "Better Castings" will appear regularly in the Abstract Section of METALS & ALLOYS. Our aim is to provide from our experience a better understanding of non-ferrous castings—to broaden our service—make new friends—and devote our efforts to help *you* make better castings.

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Operates Foundry On the Island of Madeira. J. H. QUICKE. *Foundry*, Vol. 62, Jan. 1934, pages 20, 44. Discusses the foundry industry of the island and the products made. VSP (3)

Calculate Weight on Chaplets. WARREN A. SMITH. *Foundry*, Vol. 62, Apr. 1934, pages 28, 56. Gives data on the method of calculating the size, shape and number of chaplets required for holding any given core in place. Includes formula used in the calculation. Material was obtained from experiments conducted by the author. VSP (3)

Mixing of Raw Materials in Preparing Molding Sands (Ueber die Mischung der Rohstoffe bei der Formsandaufbereitung). A. RODEHÜSER. *Die Giesserei*, Vol. 21, Oct. 26, 1934, pages 456-461. Desirable qualities of molding and filling sands are discussed, methods for preparation and cleaning and types of equipment are reviewed. Ha (3)

Humidity Affects Core Strength. F. G. SEFING & M. F. SURLS. *Foundry*, Vol. 62, July 1934, pages 14-15, 42. Discusses and tabulates results of investigation conducted on the strength and other properties of cores as affected by humidity. Results show that cores stored in highly humid atmosphere suffer loss in strength which can be regained only to a partial extent by redrying. Cores standing in a green sand mold for an hr. or more lose about 50% of their strength. Cores of large cross-section do not bake uniformly throughout, therefore baking time must be arranged with this feature in view. VSP (3)

Future of the Foundry Industry. H. W. GILLETT. *Foundry*, Vol. 62, May 1934, pages 22-23, 51-52. From a paper read before the foundry conference held at the Ohio State University. Stresses the importance of cooperation and exchange of information between plants. This seems the logical way for technician in the foundry to keep abreast of times and to forge ahead in his problems. VSP (3)

Molding in Cement (Moulané au Ciment). GROSS. *Revue de Fonderie Moderne*, Vol. 28, Oct. 25, 1934, pages 291-297. The advantages of molding in cement or cement-sand mixtures are discussed; the method is found particularly suitable for very large pieces which require lonog time to mold and often interrupted working. Preparation of cement and mixtures, molds and patterns is discussed and illustrated by examples. Ha (3)

Chronology of Foundry Practice (Chronologisches im Giessereiwesen). P. HAMMERS. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 19. 1934, pages 346-348; Sept. 2, 1934, pages 362-365. Extensive survey of history of sand dressing machinery with special reference to recent developments. GN (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Surface Oxidation of Molten Metals (L'oxydation superficielle des métaux fondus). R. DELAVAULT. *Bulletin de la Société Chimique de France*, Vol. 5, Mar. 1934, pages 419-424. The theoretical derivations of Pilling & Bedworth (*Journal Institute of Metals*, 1923, Vol. 29, page 529) on the surface oxidation of metals in the solid state are extended to the phenomena met with during the combustion of Mg and Al and practical conclusions regarding the handling of light metal alloys are furnished. The experimental results agree well with the theory. The marked effect of minute quantities of certain gases in air on the behavior of Mg is pointed out. Due to the presence of, for instance, B or Si fluoride, Mg could be held at 850°C. for several minutes without any changes. Based on the theoretical considerations the following procedure is advised when melting Mg and its alloys. Add at intervals small amounts of ammonia fluoroborate to the metal up to 500°C. In order to avoid blow-holes during solidification due to preceding gas absorption a thin cover of a 50:50 mixture of borax and ammonium (or potassium) fluoroborate is applied. On cooling this mixture is eliminated by adding fluoride (Ste. Claire-Deville process) or boric anhydride powder. EF (3a)

Action of Hydrogen Sulphide on Copper-Lead-Sulphur Alloys (Einwirkung von Schwefelwasserstoff auf Kupfer-Blei-Schwefellegierungen). W. GUERTLER & G. LANDAU. *Metall und Erz*, Vol. 31, June 1934, pages 269-273. The alloys were melted and H_2S passed over them at various temperatures, 760°-1390° C. H_2S in contact with alloys consisting of 2 layers diffuses through the upper layer and reacts at the boundary with Cu to form Cu_2S. The lower layer consists of Cu, Pb, and a little Cu_2S. The Cu_2S formed rises and the remaining Pb sinks. If the temperature is below 942°, Cu solidifies and prevents the Pb from sinking, so that H_2S diffusion is stopped. Under these conditions the maximum height of the middle layer formed was 3 mm. Above 942° Pb continues to sink to the lower layer and the reaction at the boundary goes to saturation. When the gassing was stopped suddenly, the crucible removed and quenched, a thin middle layer of .5 mm. was found. This is formed during rapid cooling either by H_2S, escaping during cooling, with Cu of the lower layer at the boundary, or by reaction of PbS from the eutectic of the upper layer with Cu of the lower layer, $PbS + 2Cu = Cu_2S + Pb$. CEM (3a)

Calculation of the Composition of the Vapor Phase over a Ternary Mixture (Berechnung der Zusamensetzung der Dampfphase über ternären Gemischen). I. KRITSCHEWSKY & J. KASARNOWSKY. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 220, Oct. 8. 1934, pages 67-72. Equations are developed for composition of the vapor. Equations verified only for organic liquids at low temperatures. WB (3a)

Metallurgy of the Haglund Process, especially of the Titanium Sulphides (Über die Metallurgie des Haglund-Verfahrens, insbesondere über die Titansulfide). J. KLEFFNER. *Metall und Erz*, Vol. 31, July 1934, pages 307-320. The reactions and formations of sulphides of Ti were studied as they affect the Haglund process for the production of Al. TiS_2 is obtained at 550° C. by the reaction $TiCl_4 + 2H_2S = TiS_2 + 4HCl$. When TiS_2 is heated in N, S dissociates and at 1000° Ti_2S_3 is formed, at higher temperatures a mixture of Ti_2S_3 and TiS. At 1400° the mass begins to sinter, at 1950° it melts, the composition being indefinite, with 45%S. Mixtures of 20 to 65% TiS_2, balance TiO_2, form fluid liquids at 1440° to 1550°. FeS and TiS_2 form a solid solution. TiS_2 deoxidizes FeS containing FeO. When a mixture of TiO_2, ZnS and coal is heated to 1200°, TiS_2 forms. At 1500° the reaction goes to completion if enough ZnS is present. When TiO_2, Sb_2S_3 and coal are heated, some Sb_2S_3 volatilizes and only 40% TiS_2 forms. TiO_2, FeS and coal heated to 1540° produces TiS_2 in a quick reaction, accompanied by a rise in temperature. Two layers are formed, one consisting of FeS and TiS_2, the other of metallic Fe, containing at 1600° only .9%Ti. When the FeS content is low, TiC and TiN are found in the slag. CEM (3a)

Porosity in Non-Ferrous Metal Castings. G. L. BAILEY. *Foundry Trade Journal*, London, Vol. 50, Mar. 15, 1934, pages 175-178. Paper read before the London branch of the Institute of British Foundrymen. See *Metals & Alloys*, Vol. 5, July 1934, page MA 315. AIK (3a)

Melting and Casting of Aluminum Brass Alloys (Herstellung und Giessen von Aluminium-Messing-Legierungen). E. T. RICHARDS. *Die Metallbörse*, Vol. 24, Mar. 31, 1934, page 408; April 7, 1934, pages 438-439; April 14, 1934, pages 470-471. Higher hardness values are obtained if Al is added first to Cu and then followed by Zn. Elongation is improved if Al and Zn are melted together and then added to the deoxidized Cu. Al in brass increases (1) density, (2) strength, (3) fluidity, (4) corrosion resistance, and (5) reduces Zn vapor formation. The strong deoxidizing effect of Al does not only improve (1) and (2), but also (3) due to the accompanying heat evolution. Quantities as small as .05% Al exert a marked effect in otherwise sluggish 40% Zn brass. Difficulties arise due to the presence of Al oxide in the castings. The sand molds should be sufficiently dry. Before adding Al, Cu should be deoxidized with P. Glass or soda slags are advantageous in reducing oxidation. P is again added shortly before pouring. EF (3a)

Die Casting (La Fonderie sous Pression). P. BASTIEN. *La Technique Moderne*, Vol. 26, June 15, 1934, pages 407-412. Reviews methods for producing die casting from the machines used to alloys. It is first pointed out that the French term "fonderie sous pression" does not distinguish die casting (in German: Spritzguss) which corresponds to casting under pressure of a metal at a fully liquid state—from press casting (in German: Warmpressguss)—which corresponds to injection under pressure of a metal at the pasty state in the dies. Machines used for this method can be classified as follows: (1) Machines with injection under action of a piston and having a hot pressure chamber located inside the crucible where the metal is melted. (2) Machine with injection under action of compressed air and having a hot pressure chamber located inside of the crucible. (3) Machines with injection under action of a piston and having a cold pressure chamber outside of the melting crucible. Design of dies aiming at uniform feeding without turbulence of the metal is dealt with, as well as defects most commonly met in die castings. Last part of the article discusses alloys used for die casting, which are classified as (1) White Pb and Sn base alloys. (2) Zn base alloys. (3) Light and ultra light alloys. (4) Cu alloys. FR (3a)

The Non-Ferrous Metal Founder Fighting Material Waste (Der Metallgiesser im Kampf gegen Materialvergeudung). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Sept. 2, 1934, pages 371. Paper discusses material waste due to uneconomic molding methods and shows that, in casting a red brass bar, diameter 40 mm., height 500 mm., weighing 12 kg., according to 5 different methods the lost weight, i.e. the total weight of gates, risers, etc., per bar cast fluctuates between 2 and 5.5 kg., whereas the metal loss because of oxidation with the most unfavorable casting method is 2¾ times as high as that with the most favorable method. GN (3a)

Difficulties in Processing a Snail Wheel (Schwierigkeiten bei der Herstellung eines Schneckenrades). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Sept. 2, 1934, page 372. In processing bronze castings difficulties were encountered that could be eliminated by applying a horn gate and arranging a rib in the casting just opposite the gate. Castings free from cracks were thus obtained. GN (3a)

Foundry Bronzes—No. 1 (Gun-Metals). *Foundry Trade Journal*, Vol. 50, Feb. 8, 1934, page 107. Brief discussion of melting-shop and foundry practice in production of copper-tin-zinc alloys. OWE (3a)

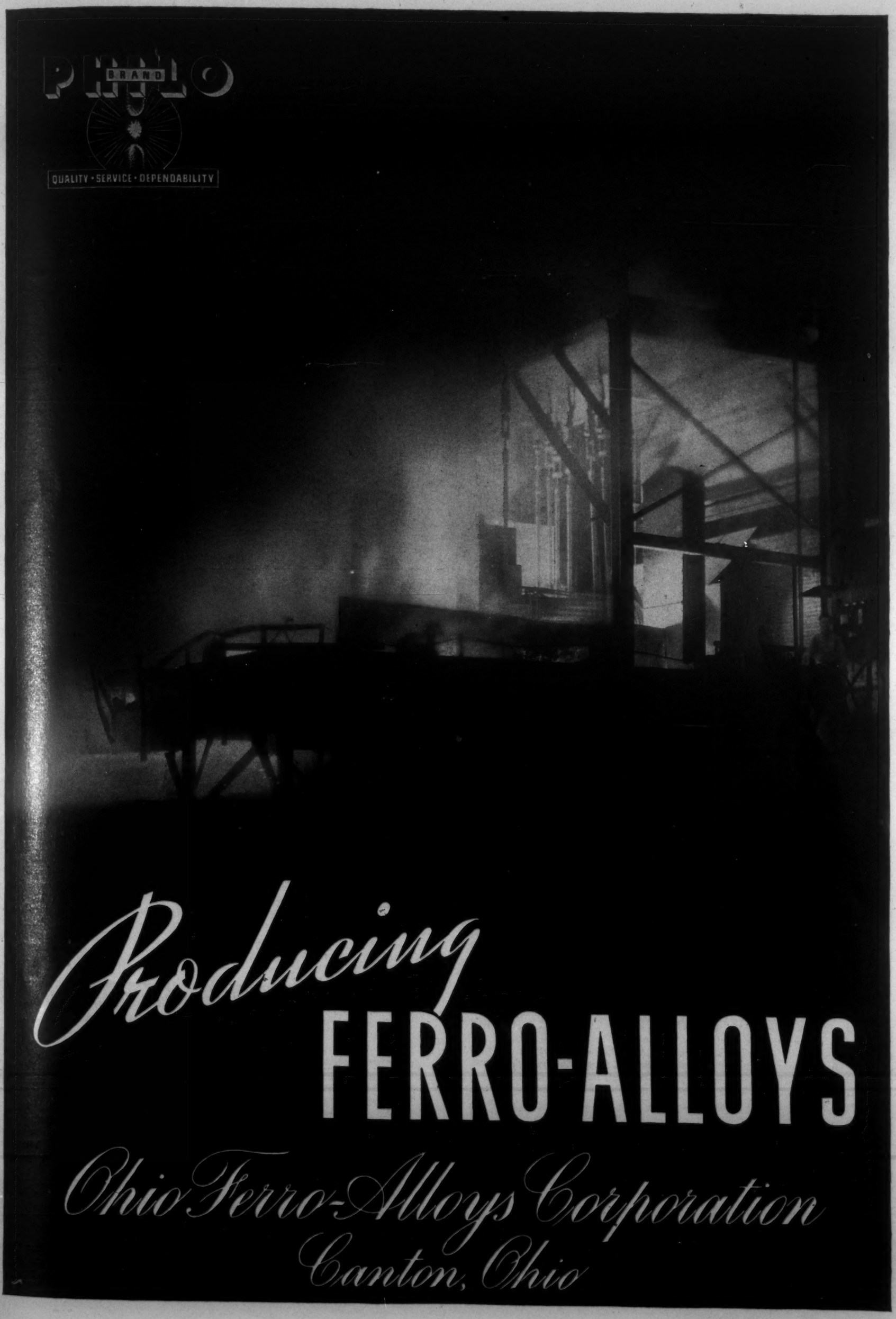
Electrolytic Recovery of Noble Metals from Drosses (Über die elektrolytische Aufarbeitung edelmetallhaltiger Gekrätz-Aschen). G. VOLKERT. *Die Metallbörse*, Vol. 24, Apr. 7, 1934, pages 437-438. Reports on experiments aiming at a wet recovery of Au and Ag. The processes developed by Siemens & Halske, Butters & Andreoli, and U. C. Tainton are briefly discussed. The unique feature of the new process is that dissolution of the noble metals and electrolytic deposition take place simultaneously. The ground noble metal bearing dross is held in suspension between the electrodes with the aid of compressed air. Experimental results on 16 tests under varying conditions are collected in 2 tables, showing the distribution of the noble metals between cathode, electrolyte and undissolved slime. Additions of NH_3 to the agitating compressed air current raised the output. Temperatures of 40°-60°C. did not affect the latter while gelatine addition of 0.1 and 0.2% proved to be detrimental. 98.1% Au and 65.5% Ag of the total amount present could be recovered from the dross and 84.5% Au and 51.7% Ag were deposited on the cathode. Free cyanide in the electrolyte is 4%, cathodic current density = 0.2-0.6 amps./dm.², voltage = 2.2-2.4 volts, time of electrolysis = 8-10 hours. EF (3a)

3b. Ferrous

C. H. HERTY, SECTION EDITOR

Various Points to be Observed in Processing Chill Rolls (Verschiedene Punkte, die bei der Herstellung von-Hartgusswalzen zu beachten sind). GUSTAV KREBS. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Sept. 2, 1934, pages 367-368, Sept. 16, 1934, pages 383-384. Summary: (1) Surface hardness increases with increasing C content, (2) depth of chill decreases with increasing C and Si content, (3) Hardness and depth of chill depend upon superheating and casting temperature, (4) the hotter the metal the deeper the chill, (5) iron left in ladle at higher temperature before pouring gives increased depth of chill, (6) wall thickness of mold amounts to from 80 to 120% of roll thickness, (7) charge low in graphite gives deeper chill than melt high in graphite, (8) surface hardness is not affected by Si content, (9) depth of chill decreases with increasing Si content, (10) Mn has no direct bearing on surface hardness, but indirectly in that increased Mn content increases absorption capacity of metal for C, (11) Mn content of .35% is most favorable, (12) higher P content gives higher surface hardness but smaller depth of chill. (13) by adding a certain amount of Ni martensite besides pearlite is formed upon disintegration of solid solution. Above a certain limit of Ni, hardness again decreases because austenite also is formed upon decomposition, (14) martensitic structure appears in chill molds with 3.6% C and 4.2% Ni, in sand cast rolls with 3% C and 8% Ni, (15) castings according to (14) possess a Brinell hardness of 660 and 350 respectively, (16) in a martensitic Fe increased C content does not so much affect hardness as it does in pearlitic Fe, (17) pearlitic chill Fe is formed with 1-3% Ni, martensitic chill Fe with 4.2% Ni when C is 3.6%, (18) hardness of pearlitic chill Fe is 520 with 1% Ni, 550 with 2% Ni, 580 with 3% Ni, (19) surface hardness depends upon the extent of decomposition of the solid solution, (20) the larger the cooling velocity the lower the Ni content required to attain decomposition, (21) finer structure and higher hardness is attained by proper casting temperature. GN (3b)

New Type Pattern Plate for Rope Pulleys (Neuartige Modellplatte für Seilrollen). HUGO HOLLWEG. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 19, 1934, pages 342-343. Description of a new type pattern plate for molding disc type rope pulleys. GN (3b)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Experiences with a New Flux in Cupola Melting (Erfahrungen mit einem neuen Zuschlag beim Kupol ofenschmelzen). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Sept. 2, 1934, pages 361-362. Paper discusses results of experiments in which a new type of flux composed of 80% powdered coke, 8% powdered coal, 8% water glass and 4% calcined soda had been used instead of limestone and fluorspar. It was claimed that of this flux .5% of the weight of Fe charge —as compared with 5% of limestone and fluorspar—were sufficient for slagging sand and ash of charge so that a number of advantages would result. However, neither one of these claimed advantages was substantiated in 2 experimental cupola melts, neither was coke saved nor the melting capacity increased nor the durability of cupola lining improved nor a better desulphurization of Fe attained, but the melting process was disturbed in that the tuyeres became clogged making further melting impossible. The only advantage of this doubtful flux is a lower cost. GN (3b)

Mold Arrangement of a Crucible for Melting White Metal (Formaufbau für einen Weissmetall-Schmelztiegel). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 19, 1934, pages 353-356. Discusses arrangement in molding a gray cast Fe crucible for mentioned purpose. Also making of sweep required in molding is considered. GN (3b)

Use of the Carbometer for the Magnetic Determination of Bath Carbon in Basic Open Hearth. D. Manterfield. *Iron & Steel Industry*, Vol. 7, Mar. 1934, pages 195-196. The use of a magnetic apparatus by means of which the bath carbon may be accurately determined in two or three minutes is described. A test piece is made up, subjected to the alternate action of two magnetic fields of different intensity; the strength of the field is changed and the electric impulse induced in a coil is registered on a galvanometer and by means of a calibration graph this induction is converted to percentage of carbon in the test piece. Results obtained are within 0.02 of combustion carbon figures. Influence of contaminating elements such as .05-.30% Ni, .03-.10% Cr, and residual amounts of Sn, Cu, and Si may be neglected. CEJ (3b)

Light Casting for Enameling. H. B. Nair. *Foundry Trade Journal*, London, Vol. 50, Mar. 1, 1934, pages 148-151. In dealing with the subject of light castings for enameling, foundryman is required to produce castings which will at least have the following properties: freedom from distortion or breakage, and freedom from surface defects or inclusions likely to interfere with the application of the enamel or the properties of the finished product. According to the author there are 2 principal sources of trouble. First, there is metal rendered unsound either by mechanically-retained inclusions or by "unbalanced" S. Such Fe can be improved by deoxidation or desulphurization. The second source of trouble is the molder's sand heap. The author discusses at length cupola cokes, limestone fluxing, soda ash treatment, molding sands and facings, coal dust additions to the facing sand, gating and pouring. AIK (3b)

Acid Alloy Steel. Working a Nickel-Chromium Steel Charge in the Furnace. J. S. Newton. *Iron & Steel Industry*, Vol. 7, Apr. 1934, page 225. A procedure, typical of modern practice described for control and routine working in the acid furnace of an alloy steel of analysis: .30-.34% C, 3.30-3.50% Ni, and .60-.70% Cr. CEJ (3b)

Avoid Sharp Corners and Edges in Castings (Vermeide scharfe Ecken und Kanten am Guss). Arno. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Oct. 14, 1934, page 435. Author shows how defective castings may be avoided by using rounded off corners and edges in castings. GN (3b)

Spur Wheel Castings. F. Oldershaw. *Foundry Trade Journal*, Vol. 50, Oct. 12, 1933, page 209. Description of method of making spur wheels where the tooth wheel machine is not available. OWE (3b)

1 **Thermochemistry of Cupola Furnaces; Its Application to the Study of Melting and of Superheating the Melt (La Thermo-Chimie des Cubilots; son Application à l'Étude de la Fusion et de la Surchauffe de la Fonte).** A. Poumay. *Revue de Fonderie Moderne*, Vol. 28, Sept. 10, 1934, pages 251-255. The importance of the thermochemical processes in the operation of a cupola furnace and the influence on them of chemical composition of the coke used is pointed out. Thermochemical calculations must be applied in order to make correct calculations of heating power of coke, composition of gases at the charging hole of the cupola, of theoretically determined and practically obtained combustion, air supply and quantity of coke required, quantities of freed gases, temperatures, thermal balances, efficiency, and of estimating appropriately the effect of changes in these different factors. 2 examples of different charges illustrate how correct application of thermochemical principles is a means for economic operation and of possible improvements. Ha (3b)

Distortion in Iron Castings on Cooling. Tom Roberts. *Iron & Steel Industry*, Vol. 7, Apr. 1934, pages 223-224. Five typical castings which have given distortion and twisting on cooling in the mold because of their design are described. Methods of overcoming difficulties by redesigning pattern and molding practice are described. CEJ (3b)

3 **Improvement of Gray Cast Iron (Étude sur l'Amelioration de la Fonte Grise).** H. Kern & A. Lessner. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, July 1934, pages 322-330. Czecho-Slovakian exchange paper presented at the Nancy Foundry Congress, July 1934. Chill cast irons, when annealed, gave great improvement in physical properties. WHS (3b)

The Loss in Temperature of Pig Iron between Blast Furnace and Converter (Ueber den Temperaturverlust des Roheisens zwischen Hochofen und Konverter). A. Graff. *Archiv für das Eisenhüttenwesen*, Vol. 8, Oct. 1934, pages 135-150. An extensive report of pig iron temperatures on tapping from the blast furnace, holding in the mixer, and transferring to the Bessemer converter. Temperature losses in the ladle and efficiencies in heating and insulation of the mixer are dealt with and also how the temperature of the pig iron in the mixer may be controlled. Large, flatly oval, mixers give the least heat losses; painting them with aluminum paint is recommended. SE (3b)

4 **Design and Manufacture of Large Tup Casting.** L. Cook. *Iron & Steel Industry*, Vol. 7, June 1934, pages 291-292. The "Tup," a 10 ton steel ball, is raised with a magnetic crane and allowed to fall on steel or iron scrap in a pit below. Steel with a composition .06-.08% C, .05% max. %, P & S, and .40-.45%, Mn is satisfactory. Mold is made up in an ordinary ladle shell with an ordinary box for the cope. "Tup" was in service for 18 months breaking approximately 30,000 tons of miscellaneous scrap. CEJ (3b)

5 **Slag Control in Steel Making.** *Metal Progress*, Vol. 24, Dec. 1934, pages 40-42, 44, 48. Summarizes papers presented at Slag Symposium, Metal Congress, 1934. "The Effect of Deoxidation on Some Properties of Steel," C. H. Herty, Jr., American Society for Metals Preprint 19, and other papers are reviewed. WLC (3b)

4. WORKING

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Vertical Motors for Vertical Rolling Mills. P. G. Lessmann. *Electric Journal*, Vol. 31, Sept. 1934, pages 371-372. Demand for higher speed continuous mills has made difficult the design of the mill and guides to handle the bar between stands. Vertical rolls on alternate stands straighten up the fast-moving bars rather than trying to turn them over. Vertical rolls are now driven by vertical motors mounted directly above the mill. Design features of the 800 h.p. motor are further discussed. CBJ (4a)

Micarta Roll Neck Bearings Applied to Rod and Other Mills. R. P. Fairgrieve. *Iron Age*, Vol. 133, May 10, 1934, pages 29-30. States that greatest advantage of using micarta roll neck bearings is where roll neck speeds exceed 15 ft./min. and H_2O is the principal lubricant. VSP (4a)

Rolling Seamless Tubes by the Foren Process. Rogers A. Fiske. *Iron Age*, Vol. 133, Mar 15, 1934, pages 24-27. Describes a unit put in operation at the plant of Globe Steel Tubes Co., Milwaukee. This mill was designed for tube diam. from 1 in. to 4 in. The tubes have wall thicknesses from No. 20 gage to ½ in. Method consists of rolling seamless tubes on a centerless ground mandrel to lengths up to 100 ft. and in all grades of steel from soft C to stainless steel. Trials showed that some non-ferrous metals can be satisfactorily and economically rolled. Speed, accuracy and flexibility are features of the mill. Fast working at proper temperatures gives uniformly fine grain structure. VSP (4a)

Shape of Passes for Rolling Angle Iron. A. P. Chekmarev. *Domez*, No. 8, 1934, pages 34-38. In Russian. Method for pass design is given which gave good results in rolling of angle iron. (4a)

An Automatic Flying Shear. Ralph H. Wright. *Electric Journal*, Vol. 31, Sept. 1934, pages 357-358, 364. The flying shear comes from rest to full speed in 0.6 sec. and cuts a bar of rolled steel moving at a high speed with an accuracy of 1%. The motor characteristics for this machine are discussed. CBJ (4a)

Variation of Substance in Tinplates. J. Selwyn Caswell. *Iron & Coal Trades Review*, Vol. 129, Nov. 9, 1934, pages 715-716. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. Ha (4a)

Completes New Sheet Lead Mill. *Iron Age*, Vol. 134, July 26, 1934, pages 35, 80. Describes sheet Pb manufacturing plant of the Flemm Lead Co., Inc., Long Island, N. Y., which was recently opened. VSP (4a)

7 **A Modern Copper Rod Mill (Ein neuzeitliches Kupferdrahtwalzwerk).** *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Oct. 14, 1934, pages 642-644. Detailed description of rod mill installed at Milano plant of Societa Italiana Pirelli. The mill was built by Krupp-Gruson Works, Maddeburg-Buckau. GN (4a)

Speeds with the Automatic Sheet Catcher. W. B. Snyder & T. R. Rhea. *Iron Age*, Vol. 133, Feb. 22, 1934, pages 26-28. Presents results of an oscillograph time study made on automatic sheet catcher equipment. Tests were made upon a Wean Engineering Co. catcher. Includes tables showing observed time cycle and calculated time cycle. VSP (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

Forging Rustless Steel. Rogers A. Fiske. *Iron Age*, Vol. 133, Feb. 22, 1934, pages 14-15. Describes method used at the plant of Charles E. Larson & Sons, Inc., Chicago. Furnaces used are low-heat and high-heat. Pieces are brought up slowly to temperatures between 1400° and 1500° F. Billets brought up to preheating temperature are transferred to a high-heat furnace where the temperature is between 1800° to 2000° F. Cracked forgings will result if heating is too rapid or forged below 1700° F. Stainless steel is hammer forged less vigorously than most steels. VSP (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

10 **Stampings—I. Parts Produced by Swaging.** J. K. Olsen. *Product Engineering*, Vol. 5, Dec. 1934, pages 442-445. Examples illustrate how shaping of sections by swaging can often be employed more advantageously than upsetting, cold-forging, etc. Ha (4c)

Giant Plate Bending and Straightening Machine for Ship-building (Schwere Plattenricht- und -biegemaschine für den Schiffbau). Fr. Puppe. *Schiffbau, Schiffahrt & Hafenbau,* Vol. 35, Mar. 1, 1934, pages 70-72, 76-77. A giant combined plate-bending and straightening machine of the Schiess-Defries Co., Düsseldorf, is described in detail. Maximum working width = 10.5 m.; max. plate thickness for straightening = 45 mm. and for bending = 60 mm. WH (4c) 1

Strain Hardening of Metals by Cold Working (Verfestigung der Metalle durch Kaltreckung). W. Fuller. *Die Umschau in Wissenschaft & Technik,* Vol. 38, July 1, 1934, pages 528-530. The problem of strain hardening of metals due to cold working has not been entirely solved. Data of Tammann and Heyn on slip are summed up. X-ray investigations however revealed that there are no considerable space lattice disturbances due to cold working. Theoretical calculations yielded a far greater tensile strength of hypothetical crystals than those actually measured. Tammann suggested that the atoms themselves must be affected by cold working. His experimental work on the recovery phenomena studied on different groups of metals and alloys are summarized. WH (4c) 2

Drawing of Fine Wires with Diamond Dies (Das Ziehen feiner Drähte mittels Diamantenziehsteinen). P. Grodzinski. *Technisches Zentralblatt für praktische Metallbearbeitung,* Vol. 44, 1934, No. 11/12, pages 228-232; No. 13/14, pages 275-277. Diamond dies for wire drawing are made by drilling with soft steel needles and diamond dust suspended in oil. The hole is drilled from both sides at 2000 r.p.m. and 250 impacts/min. starting with the largest diameter. This operation takes several days. The die is provided with a more slender cone-shaped inlet for W and steel, while in the case of Cu a large opening angle is suited best. The drawing velocity for Cu is about 25 m./sec. and wire gages are 0.13-1.4 mm. whereas W wires of 0.01-0.3 mm. diameter are feasible. After drawing 5-10 million meters of Cu wire, the diamond die must be repolished or provided with a larger hole. A die for 1.4 mm. wire weight about 1 g. and 0.05 g. for 0.05 mm. wire gages. The diamond dies are mounted in brass or cast into cast steel. Elementary formulae for calculating the drawing passes and literature references are given. EF (4c) 3 4

4d. Machining

H. W. GRAHAM, SECTION EDITOR

The Advantages of the Latest Cutting Materials. W. Muirhead. *Journal Institution Production Engineers,* Vol. 13, June 1934, pages 285-302. Includes discussion. Savings and new applications following the use of 22% W steel, stellite, and cemented carbide tools are discussed and illustrated by examples —principally of the use of cemented tungsten carbide. JCC (4d) 5

Chipforming Machining of Light Metals (Spanabhebende Bearbeitung von Leichtmetallen). A. v. Zeerleder. *Berg- und Hüttenmännisches Jahrbuch,* Vol. 82, Sept. 28, 1934, pages 144-147. High speed steel tools must be used for machining light metals; shape and cutting angles for different light alloys, depth of cut and speed of feed are discussed. The cutting speeds recommended for various processes are:

Milling, rough	200-1200 m./sec.
Milling, finish	600-1500 m./sec.
Turning	200- 800 m./sec.
Sawing	600-3000 m./sec.
Drilling	100- 400 m./sec.
Thread	10- 40 m./sec.

Power consumption can be calculated, in general, on the basis of 1 h.p. for 70-100 cc. chips per min. Ha (4d) 6

Tungsten Carbides (Hartmetalle). Przygode. *Die Wärme,* Vol. 57, Sept. 8, 1934, pages 587-588. Special W carbides (Widia) are made by Krupp for different kinds of materials to be machined. Impacts during cutting of off-center objects are withstood, since Widia is not only almost as hard as diamond, but also very tough. The following data on machining of various materials are given: 7

	cutting speed in m./min.	feed in mm./revolution	cutting depth in mm.
Nirosta (70 kg./mm.²)	35	.8	7
Open hearth steel (60 kg./mm.²)	240	1.2	6
Harder castings (86 Shore)	5	1.5	3
12% Mn steel (360 Brinell)	12	1.2	6

Germany produces 20,000 kg. W carbides per annum, 1/3 of which are exported. EF (4d) 8

Tolerances in Automotive Production. P. M. Heldt. *Automotive Industries,* Vol. 71, Oct. 20, 1934, pages 466-468, 484. A discussion of tolerances permitted in current American passenger cars. Complete tabular data of the ranges of tolerance permitted for practically all important moving parts of the engine and chassis are given in *Automotive Industries,* Vol. 71, Oct. 27, 1934, pages 514-519. BWG (4d)

Tungsten Carbide Reduces Tool Sharpening. Chas. O. Herb. *Machinery,* N. Y., Vol. 41, Dec. 1934, pages 213-215. Experiences with Widia tools are reported; when used for machining parts within tolerances of 0.0005" they lasted up to 8 months between lapping. Ha (4d) 9

Some of the Factors Which Affect the Roughness of Turned Pieces (Note sur quelques-uns des Facteurs qui agissent sur la Rugosité des Pièces tournées). E. Bodart. *Revue Universelle des Mines,* Vol. 10, Nov. 1, 1934, pages 565-572. The influence of feed, cutting velocity and shape of tool on the smoothness of the turned surface is investigated theoretically and experimentally. For feeds greater than 0.4 mm./min. the profile agrees very well with the theory, i.e. it approaches the desired smooth surface; for smaller values the irregularities are greater. The higher the cutting speed the more the irregularities of the profile disappear. In order to obtain a good polish (smoothness) appreciable heating during cutting should be avoided. 6 references. Ha (4d) 10

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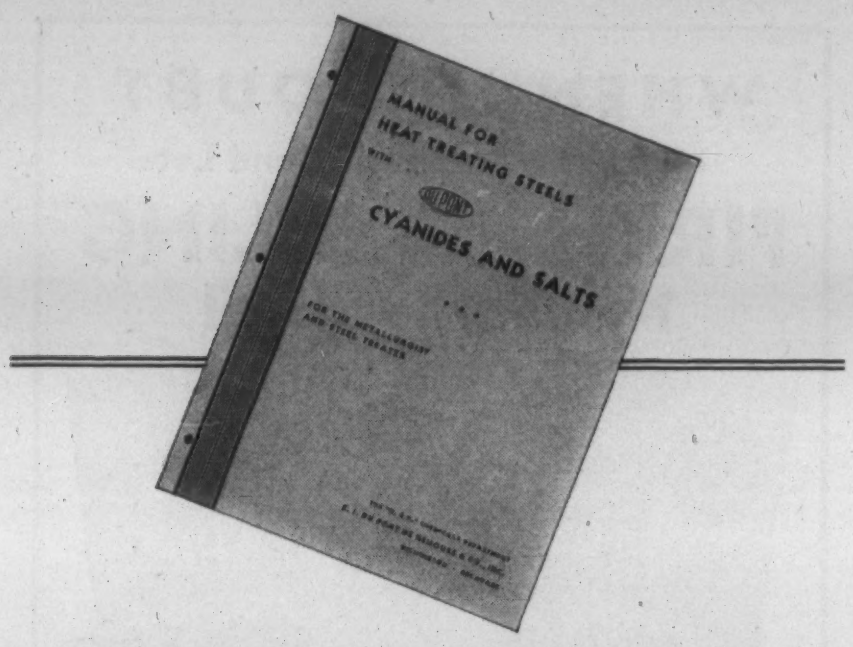

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

Metallography and Heat Treatment. Second edition. N. F. Bolkhovitinov. Gosudarstvennoe Naouchno-Technicheskoye Izdatelstvo, Moscow, 1933. Cloth, 6 x 9 inches, 694 pages. Price 9.25 roubles. The book describes mechanical testing giving both the usual and less common methods and their theories, particularly those connected with abrasion, fatigue and creep characteristics of the metals. The treatment is brief, accurate and to the point, though covering an exceptionally wide field. The description of metallographic practice would be a credit to a book dealing with metallography alone. Listing of etching reagents is exceptionally complete. Magnetic, thermal, and X-ray testing are adequately covered from the theoretical standpoint and are illustrated by a wealth of factual evidence. Two chapters on theoretical metallurgy are followed by chapters on its application to the study of steel, cast iron and non-ferrous metals, very well documented. Heat treatment is in a special section, though the results of its practical application are found together with the description of the metals to which it was applied. The latest developments in cementation, cyanization, nitrogenation, chromium coating, calorizing and extra hard materials are fully recorded. Taken as a whole the accuracy of the book is high, but some mistakes can be found. Polishing practice used by the author is practically obsolete. Very few people will agree with him that at the moment there is a strong tendency for taking photomicrographs at 15,000 diameters. That metallographic polishing inevitably brings a cold deformation of the surface is not generally accepted. The prefixes micro- and macro- are often interchanged. Flux additions to the cupola are far less common than is claimed by this book. The difference between cast iron and pig iron is not pronounced enough to justify their separate treatment. It is difficult to concur with the statement that steel axles are hardened at the Ford plant on the surface only (presumably without carburizing). However, the logical clearness of this book distinguishes it favorably from the many already existing in the field. The story follows its sharply defined path without undue deviations or losing itself in a maze of data. (5) —B—

Effect of Heat Treatments on the Properties of Die Steels. T. Murakami & A. Hatta. *Iron Age*, Vol. 134, July 5, 1934, pages 22-27, 88. See "On the Change of Properties of Die Steels Due to Heat Treatment." *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 78. VSP (5)

Thermal Method of Autostabilisation and its use in Study of Some Heat Resisting Steels (La methode d'autostabilisation thérmique et son utilisation à L'etude de quelques aciers resistant a chaud). G. Ranque & P. Henry. *Aciers Spéciaux, Métaux et Alliages*, Vol. 9, June 1934, pages 176-195. Presented at the third Congress of Industrial Heating (Paris, 1933). See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 538. GTM (5)

Jobbing Shop for Heat Treating. J. B. Nealey. *Iron Age*, Vol. 133, Feb. 22, 1934, pages 29-31, 68. Describes the equipment used for heat treating steel parts at the plant of the Lindberg Steel Treating Co., Chicago. More than 40 furnaces are needed to handle the work of this firm. VSP (5)

5a. Annealing

Blue Edges on Sheets in Box Annealing. Eric R. Mort. *Iron Age*, Vol. 133, June 14, 1934, page 21. Brief abstract of paper read before the British Iron & Steel Institute. See "The Manufacture of Full-finished Steel Sheets," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. VSP (5a)

Selecting Carburizing Boxes. *Machinery*, N. Y., Vol. 41, Dec. 1934, page 226. Points to be taken into account when choosing between welded and cast boxes for carburizing are discussed; handling costs are one of the most important items. Welded boxes are usually lighter and therefore more convenient in transport. At present, alloys containing upward of 60% Ni with from 15-25% Cr are favored for this purpose. 25% Ni and 20% Cr has given good service in rolled material. Ha (5a)

5b. Hardening, Quenching & Drawing

The Effects of Special Elements on the Velocity of Expansion due to Martensitization during Quenching of Steel. Takejirô Murakami & Atuyoshi Hatta. *Tetsu to Hagane*, Vol. 20, Sept. 1934, pages 649-657. In Japanese. Automatic recording apparatus of expansion-time curve during quenching of steel was constructed. With this apparatus, the expansion-time curve was obtained for 4 C steels and 32 steels containing less than 2% Mn, Ni, Co, V, Cr, Si, W or Mo with nearly eutectoid C content. The quenching temperature varied from 850° to 1100° C., the quenching medium being oil. The velocity of expansion due to martensitization was calculated by the following formula, $dx/dt = K(a-x)$, in which x shows the amount of martensite formed in time, t, a, amount of martensite after cooling to room temperature, and K a constant. Then, the velocity of martensitization is shown by $dx/dt = Ka/2$, when x is a/2. By the value Ka/2 the effects of special elements and quenching temperature on the velocity of expansion were studied. The values Ka/2 change with the rise of quenching temperature, the maximum value being the case quenched from 900°~1000° C. The beginning temperature of martensitization generally falls, as the quenching temperature rises. In the plain C steel of nearly eutectoid composition the martensite is formed by oil quenching, while in those of the hyper- and hypo-eutectoid composition the troostite is formed by the same operation. In alloy steels tested in the present work, the martensitization takes place on quenching in oil, except in 1.94% Co steel. The velocity and amount of expansion of V steels are small and those of W steels are large. Among the steels containing 0.5 and 1% of special element added, Mn steel has the largest velocity of expansion, while among those with 1.5% or 2% of special element, W steel is the largest. TM (5b)

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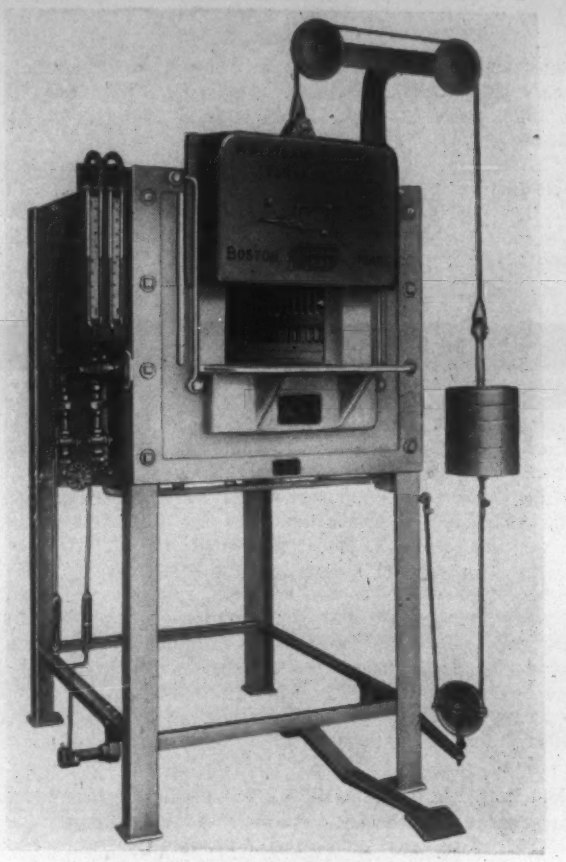

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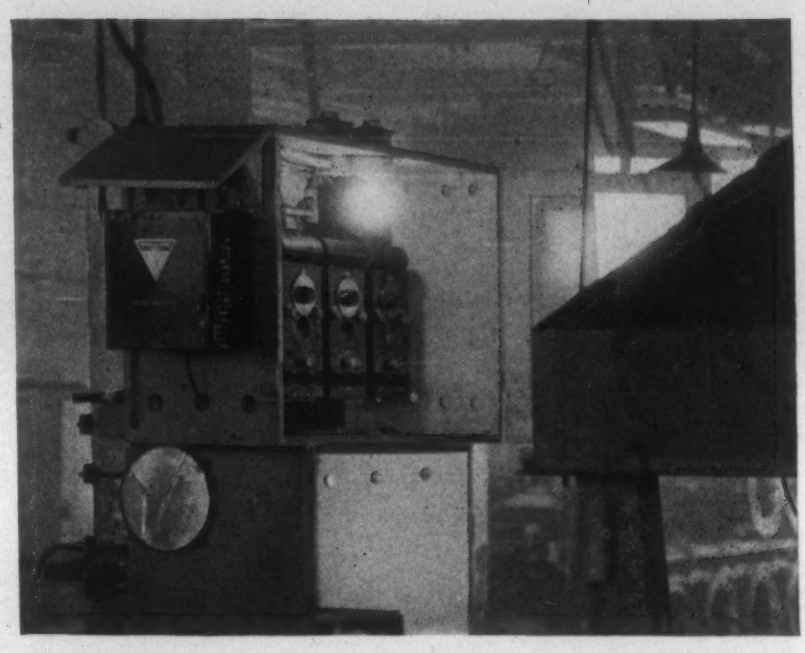

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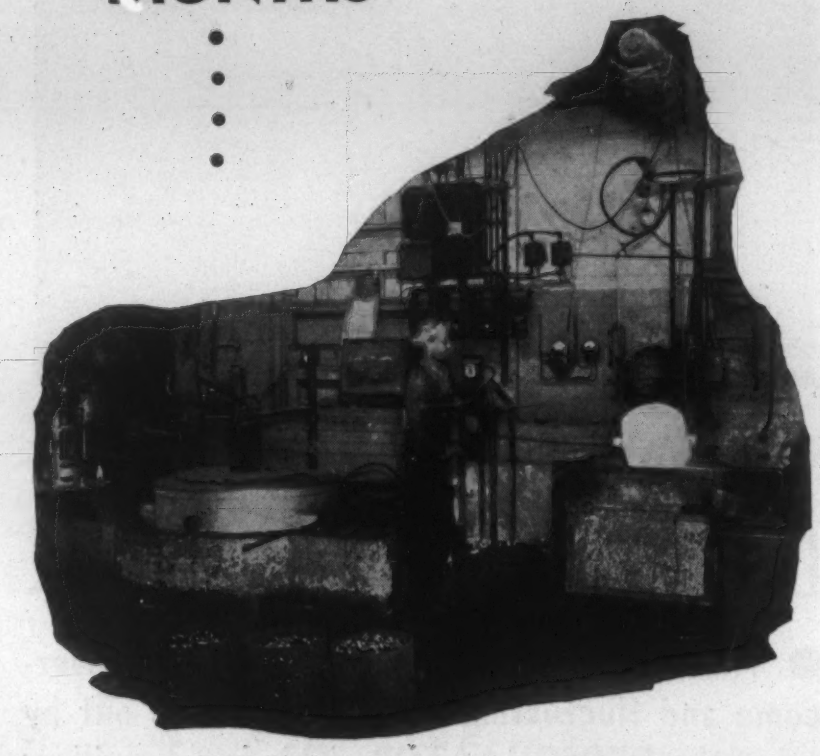

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Uniform Hardening of Large Bearing Races. Bengt Kjerrman. *Metal Progress*, Vol. 24, Dec. 1934, pages 27-31. Solution of difficulties in hardening Cr bearing steel without soft spots is described. Regulation of flow of gas and air to furnaces on a program achieved the desired end. During soaking and heating the gas atmosphere of the furnace was slightly decarburizing but for a few minutes prior to quenching an oxidizing atmosphere was maintained which resulted in scaling off the decarburization and elimination of soft spots. WLC (5b)

Effect of Facing on Quenching Efficiency. Seikichi Sato. *Iron Age*, Vol. 133, Feb. 22, 1934, pages 16-17, 68. See "Effect of Facing on the Cooling Velocity of a Specimen During Quenching," *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 17. VSP (5b)

Quenching and Drawing Phenomena in Alloys (Les Phénomènes de Trempe et de Revenu dans les Alliages). A. Portevin. *La Technique Moderne*, Vol. 26, Oct. 15, 1934, pages 682-690. See *Metals & Alloys*, Vol. 5, May 1934, page MA 185. FR (5b)

Heat-Treating in an Automobile Plant. J. B. Nealey. *Machinery*, N. Y., Vol. 41, Dec. 1934, pages 201-205. Layout of heating plant of 32 gas-fired continuous furnaces, temperature control, and testing of hardness in the Dodge plant is described. Ha (5b)

5e. Carburizing

On the Catalysers for the Cementation of Iron. Keizô Iwasé & Waiti Ota. *Kinzoku no Kenkyu*, Vol. 11, Sept. 1934, pages 413-421. To find powerful catalysers for the cementation of mild steel with charcoal, experiments were carried out at 950° C. with various chlorides of alkali and alkali earth metals, changing their quantities in a wide range. The experiment was also performed to see the effect of the temperature upon the C content at the surface of the specimen and the depth of the C penetrated into it. As the results of many investigations it was found that a mixture consisting of 10% NaCl and 10% Na_2CO_3 was found to be a more powerful catalyser than Ba_2CO_3. As to the effect of heating temperature upon the carburisation it was found that with a solid carburizing material no free cementite is formed at the surface of the specimen in spite of the high temperature applied, while with a gaseous carburizing material a free cementite may be formed according to the metastable equilibrium $3\,Fe + Co \leftrightarrows Fe_3C + CO_2$. The depth of the C penetration increases as does the velocity of diffusion of the C in Fe. KT (5e)

Electric Heat Institute (1923-1933) (Elektrowärme-Institut 1923-1933) W. Hessenbruch & K. Schichtel. *Elektrowärme*, Vol. 4, July 1934, pages 162-164. The report which this institute publishes on its activity over the first 10 years also contains tests with different kinds of steels heated and carburized at 900-1200° C. in reducing and carburizing atmospheres. Ha (5e)

Various Methods of Carburizing. II. E. F. Davis. *Industrial Heating*, Nov. 1934, pages 115-118. Furnaces for the carburizing process are discussed; stationary, rotating, continuous counterflow and return counterflow are types in use. Ha (5e)

5f. Nitriding

Investigations into the Nitrogen-Hardening of Steels. Part II. The Nitriding Properties of Some Chromium and Austenitic Steels at a Temperature of 500°C. B. Jones. *Iron and Steel Institute, Carnegie Scholarship Memoirs*, Vol. 22, 1933, pages 51-96. Section I deals with the nitrogen hardening of some chromium steels and of steels containing chromium as a constituent. Twenty-eight steels were used. Ammonia gas, giving a dissociation of 20 to 25% at the furnace exit was used for nitriding. Steels containing 1 to 18% chromium were effectively hardened. 500°C is a suitable temperature for nitrogen hardening many steels containing chromium. Steels containing 1 to 3% chromium, with or without other elements, will harden to 500 to 1000 Vickers Brinell. The depth-hardening in steels containing less than 2% of chromium is usually greater than in an aluminum bearing nitriding steel. Nickel added to chromium steels decreases surface hardness on nitriding; vanadium, molybdenum, and tungsten increase the surface hardness. Steels containing 8 to 18% chromium harden to more than 1000 Vickers Brinell. The depth of hardening extends 0.008 to 0.012 in. below the surface. The absorption of nitrogen by high chromium stainless steels results in a decreased resistance of the surface to corroding media. Section II deals with the nitrogen hardening of austenitic steels. Nineteen steels were investigated. Steels containing 10 to 23% of manganese harden to 700 to 1100 Vickers Brinell. The core hardness is raised in nitriding manganese steels due to the γ-α iron inversion. Austenitic nickel steels do not harden by nitriding. Austenitic chromium-nickel and chromium-nickel-tungsten steels do not harden consistently by the usual process. However, previous pickling in hydrochloric acid before nitriding and nitriding under increased pressure will give hardening in 18/8 chromium-nickel steel to more than 1000 Vickers Brinell and depth hardening to 0.008". Beyond 18/8 the nitriding is more difficult. When nitriding is carried out in the presence of copper, greater hardening results in certain steels difficult to harden by other methods, showing that copper may accelerate the nitriding process. Austenitic steels that were non-magnetic become slightly magnetic after hardening by nitriding. The increased hardness is due to the formation of finely dispersed and insoluble particles of complex nitrides in α iron causing lattice distortion and resistance to slip. 17 references. CW (5f)

Nitralloy Steel and Nitriding. J. McCrone. *Journal Institution Production Engineers*, Vol. 13, July 1934, pages 349-375. Includes discussion. A paper read before the Glasgow section of the Institute. Parts to be surface-hardened by the nitriding process are made from chrome-aluminum steel containing 1.4-1.8% Cr and 0.9-1.3% Al. Four grades are available containing 0.2-0.6% carbon, with strengths from 35 to 90 tons/in.^{2} Portions to be kept soft are first protected by tinning, and then the parts heated in an atmosphere of anhydrous ammonia to 932° F. being cooled slowly. Heating for 90 hrs. or longer gives a case 0.030" deep; for 20 hrs. 0.008" deep. The diamond indentation hardness of the case is 1020-1170, and this is well retained under hot working conditions. Growth and distortion during nitriding are small in amount, but should be allowed for. Some typical applications are described. JCC (5f)

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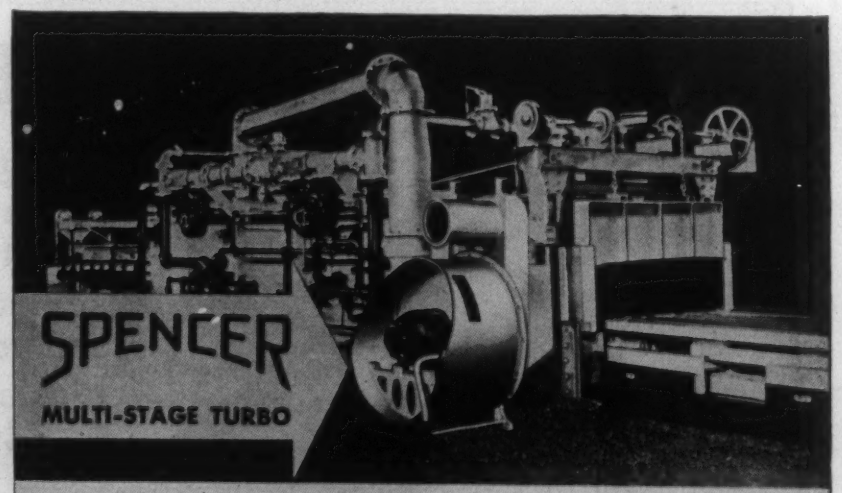

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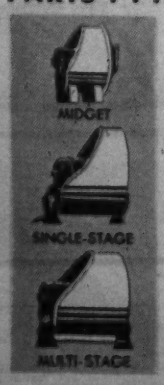

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6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Uses Recuperator on Air Furnace. *Foundry*, Vol. 62, Feb. 1934, pages 11, 52. Describes a recuperator installed on an air furnace at the plant of the Eastern Malleable Iron Co., Naugatuck, Conn., supplied by the Carborundum Co. Furnace is a pulverized coal fired unit of 30-ton capacity. The recuperator is mounted on an elevated platform at the stack end of the furnace. Advantages claimed are: average fuel saving of 22%, time required to bring the heat to pouring has been reduced about 10%, hotter flame and shorter exposure of metal to flame is producing less oxidation, reduces amount of S resulting in less contamination of metal. VSP (6)

1

Melting Furnaces with Electric Resistance Heating (Elektrische Schmelzöfen mit Widerstandsheizung). *Elektrizitätswirtschaft*, Vol. 33, Sept. 15, 1934, page 353. Illustrated and discussed are (1) small melting pots for 400°-450° C. max. and (2) small tilting melting furnaces for 750° C. max. on the German market. Data on both groups are collected in 2 tables which refer to diameter, depth of hearth, capacity, energy for heating up and energy for holding the furnace at service temperature, weight, kind of current. WH (6)

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Running Iron Blast Furnace for Ammonia Manufacture. B. M. Suslov. *Iron Age*, Vol. 134, July 26, 1934, pages 22-24. P. Chechin proposes that blast furnace be used as a producer for NH_3 synthesis, entailing an important change in blast furnace process and in construction. Blast furnace must operate on cold blast containing 55-60% O. Conversion of CO to be accomplished in shaft by steam so that about 12-15% of free CO remain in gas mixture. Converted gas from furnace to be cooled and washed with ethanolamine solution under atmospheric pressure to remove CO_2. Then CO and gas mixture is subjected to a secondary conversion by steam in presence of calcined dolomite in special converter, in which CO_2 and remains of CO are completely removed. Includes tables. VSP (6)

—

Tube Type Annealing Furnaces. Lee Wilson. *Iron & Steel Engineer*, Vol. 11, Aug. 1934, pages 280-283. Read and discussed at Youngstown meeting Association of Iron and Steel Electrical Engineers, Apr. 1934. Cost data given on annealing of sheets show lower investment and operating cost for furnace design described. WLC (6)

2

A Ten-kilowatt Granular Carbon-resistance Furnace. J. W. Cuthbertson. *Metallurgia*, Vol. 10, Sept. 1934, pages 141-147. Furnaces with a resistor of granular C make good laboratory furnaces. In one described, 10 or 15 lb. of metal can be heated to more than 1600°C. in less than an hr. Characteristics of the furnace are discussed and directions are given for making the furnace. Selection of proper refractories is important. JLG (6)

—

New Silicon-Carbide Refractory Brick. G. S. Diamond. *Iron Age*, Vol. 131, June 8, 1933, pages 896, 914. *New Refractory for Electric Furnaces*, *Metal Industry*, N. Y., Vol. 31, June 1933, page 209. Abstract of paper read before the Electrochemical Society, May 1933. A description is given of an improved silicon carbide refractory brick for electric furnaces. PRK + VSP (6)

—

Pack and Pair Heating Furnaces. R. J. Wean. *Iron & Steel Engineer*, Vol. 11, Feb. 1934, pages 67-75; *Fuels & Furnaces*, Vol. 11, Nov. & Dec. 1933, pages 219-220. Paper read and discussed at Pittsburgh Convention, Association of Iron and Steel Electrical Engineers, Oct. 1933. WLC (6)

—

Anneals Malleable in Small Furnace. L. J. Wise. *Foundry*, Vol. 62, July 1934, pages 21, 54. See "Annealing Malleable in Small Furnace Proves Economical," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 522. VSP (6)

2

Gas Furnace in a Pipe Plant. *Iron Age*, Vol. 133, Feb. 1, 1934, pages 30-32. Describes gas fired furnaces for heating skelp, for normalizing finished pipe, for heating Zn pot for galvanizing and for steam raising employed by the Pittsburgh Tube Co. at Monaca, Pa. VSP (6)

—

Temperature Distribution of Electric Furnace Compared with Fuel Fired Furnaces. Wirt S. Scott. *Iron & Steel Engineer*, Vol. 11, July 1934, pages 257-265. Discussion. WLC (6)

3

Insulating Firebrick Applications in Steel Heating Furnaces. M. J. Terman. *Iron & Steel Engineer*, Vol. 11, June 1934, pages 218-223. Data are given on heat flow through various types of furnace wall construction. WLC (6)

—

Bath Furnaces for Exact Heat Treating. S. Z. Owen. *Electric Journal*, Vol. 31, June 1934, pages 224-225. Advantages of electrically heated bath furnaces are: (1) Evenly distributed temperatures; (2) safe working conditions, no products of combustion; (3) elimination of fire hazard, no flame; (4) purity of oil in bath is preserved since it is not overheated, carburization of oil is eliminated; (5) convenience of location; (6) duplication of results, elimination of rejects; (7) low maintenance costs; (8) relatively low first cost; (9) portable in the small sizes. CBJ (6)

4

Use of Electric Furnace for Box Annealing. A. N. Otis. *Iron & Steel Engineer*, Vol. 11, July 1934, pages 248-257. Read and discussed at Youngstown Meeting, Association of Iron and Steel Electrical Engineers, Apr. 1934. WLC (6)

—

A REAL **SUPER**-REFRACTORY

Unaffected by Oxidizing or Reducing Atmospheres
No Permanent Shrinkage or Expansion
at 2550°F—Less than 0.5% at 3000°F
No Deformation in A.S.T.M.
Standard Load Test
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3300°F

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Preburned Shapes, Cements
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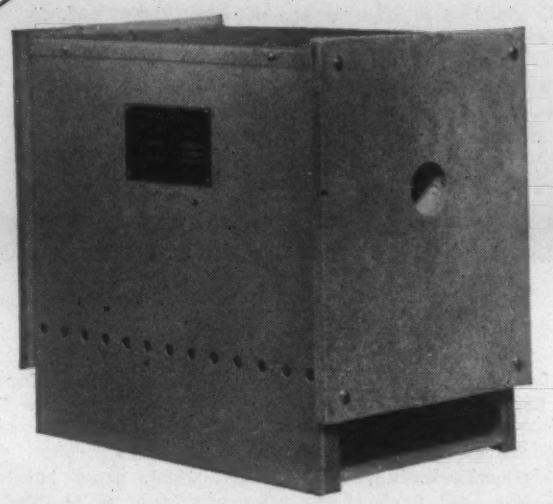

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A NEW METALLIC HEATING ELEMENT with exceptionally long life. Greatly increases the furnace's dependability for uninterrupted service. Maintenance cost exceptionally low.

Temperature is controlled between 1100° F. and 2300° F. by a regulating transformer.

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HEAT TREATING FURNACES

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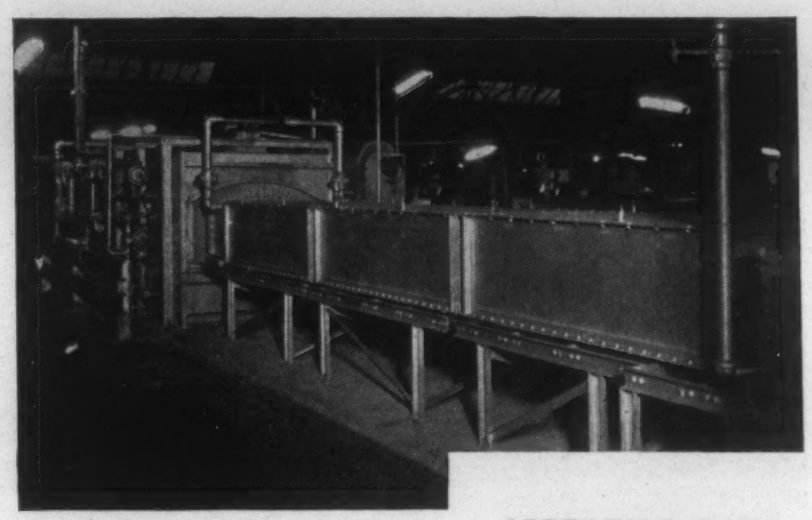
HOW EF BRICK HELPS CUT *production costs*

IN THIS SC CONTROLLED ATMOSPHERE FURNACE



SC Controlled Atmosphere Furnace for clean-annealing pressed steel automobile wheels. Cooling chamber is shown in foreground.

IMPORTANT are the economies effected by the SC Controlled Atmosphere Furnace shown above—in the elimination of pickling, in the reduction of labor and handling, in preventing heating of excess material.

And vitally important, too, are the other savings and advantages offered by this furnace for which Armstrong's EF Brick is in no small part responsible . . . such things as lower fuel cost, more uniform production, improved quality.

For EF Brick requires no fire brick protection. This semi-refractory brick makes possible thinner walls, quicker heating with less fuel consumption . . . and a consequent sharper furnace. Constant temperatures can be more easily maintained with furnaces built of EF Brick, too, insuring uniform quality production.

You'll find it will pay you to investigate Armstrong's EF Brick carefully. For data and samples write Armstrong Cork Products Company, Insulation Division, 982 Concord Street, Lancaster, Pennsylvania.

OPERATING DATA

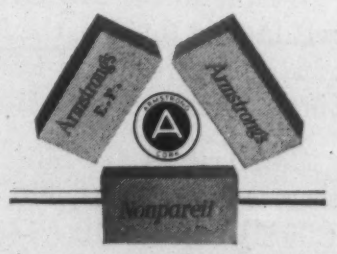
on the SC furnace shown above*

Total gas required (for heating work and preparing atmosphere) per net pound of work treated, is equivalent to 1.2 cu. ft. of city gas; .645 cu. ft. of natural gas; .208 cu. ft. of Butane gas.

Total cost per net pound of work for heating and atmosphere gas, $0.00077.

Production: 2160 lbs. of work or 650 stampings per hour.

**Quoted from publication of Surface Combustion Corp., Toledo, Ohio.*



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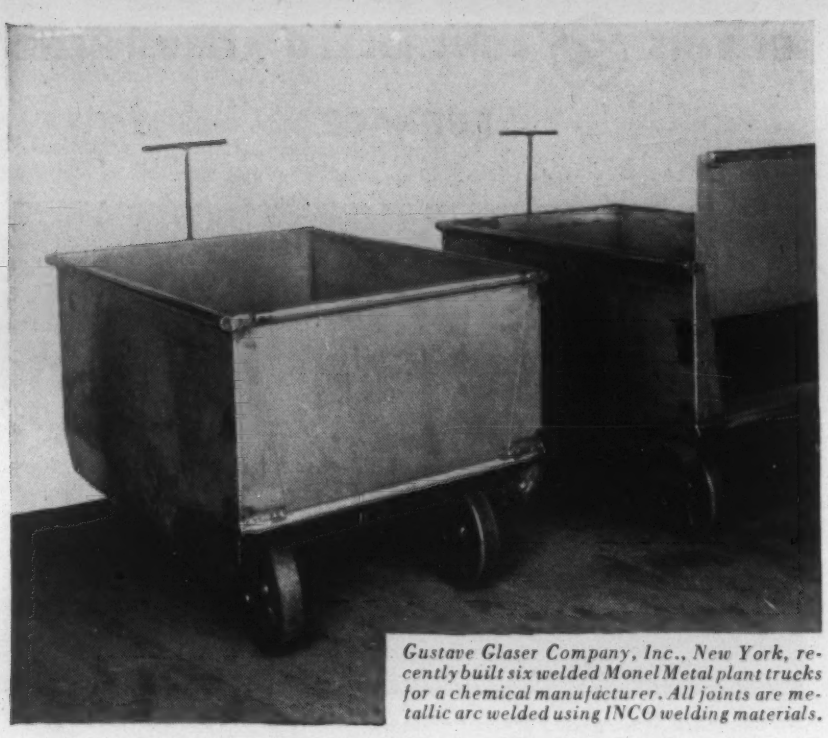
HIGH TEMPERATURE PRODUCTS

Armstrong's*, EF, *and Nonpareil Insulating Brick

WELDED MONEL METAL



Gustave Glaser Company, Inc., New York, recently built six welded Monel Metal plant trucks for a chemical manufacturer. All joints are metallic arc welded using INCO welding materials.

..by the "TRUCKLOAD"

THE trucks shown above are excellent examples of welded Monel Metal. There were six made on one order, and each had about 35 lineal feet of welding on it.

Yet in all the 210 feet of welding on this job, the fabricator reports there isn't a single flaw.

The trucks are built of sheet Monel Metal, No. 13 (.093") and No. 10 (.140") Gauge. Rod used was Monel Metal arc welding rod No. 30 ($\frac{3}{32}$") and No. 34 ($\frac{1}{8}$").

While these trucks were built for a chemical plant, they are typical of welded Monel Metal equipment widely used in all types of industry.

* * *

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

INCO WELDING RODS & FLUXES

***for* PURE NICKEL**

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

***for* MONEL METAL**

Oxy-Acetylene . . . Monel Gas Welding Wire. (For flux, see * below.)
Metallic Arc . . . INCO Monel Metallic Arc Welding Wire No. 30 and No. 34.
Carbon Arc . . . INCO Monel Carbon Arc Welding Wire No. 20.

***for* INCONEL**

Oxy-Acetylene . . . Inconel Gas Welding Wire. (For flux, see ** below.)
Metallic Arc . . . Inconel Metallic Arc Welding Wire No. 32.

***for* NICKEL-CLAD STEEL**
(for welding of Nickel side)

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31 and No. 35.†
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

•

FLUXES

* Use INCO Gas Welding and Brazing Flux for Monel Metal.
** "Cromalloy" Gas Welding Flux is recommended for Inconel.
† For vertical welding.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

•

INCO welding materials as listed can most conveniently be obtained through regular INCO distributors.

Detailed welding instructions furnished on request.

Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

NRA CODE

7. JOINING

7a. Soldering & Brazing

C. H. CHATFIELD, SECTION EDITOR

Progress in Brazing (Les Progrès de la Soudo-Brasure). *Revue de la Soudure Autogène,* Vol. 26, Sept. 1934, page 5. Previous objections to the method were: (1) Operation is accompanied by evolution of Zn fumes and (2) Color of the joint is not the same as that of the piece and appearance of the work is poor. These points have received due attention during the last 2 months: (1) Addition of other metals has been studied and new alloys have already been developed which give almost no Zn fumes, (2) A white brazing alloy has been obtained by adding a suitable quantity of Ni to the brass usually used. This new alloy is satisfactory and, specially, shows good "wetting" properties. It is hoped that the method will be used not only in repair work but also in manufacturing processes. FR (7a)

7b. Welding & Cutting

C. A. McCUNE, SECTION EDITOR

On the Composition of Arc Welded Seams in their Dependence Upon the Type of Base Material, Electrode and Welding Conditions (Über die Zusammensetzung von Lichtbogenschweissnähten in ihrer Abhängigkeit von der Art des Grundwerkstoffes und der Elektrode sowie von den Schweissbedingungen). ERICH HAARDT. *Die Elektroschweissung,* Vol. 5, Sept. 1934, pages 161-164; Oct. 1934, pages 193-196. Arc welds of one layer were made of Si, Mn, Cr, Ni and Cu steels with common unalloyed non-coated and coated electrodes. The welding current was 110, 155 and 175 amps., so that, consequently, the welding speed also varied. The diffusion capacity of the alloying constituents varied with the welding current. In general largest diffusion was apparent with 175 amps., smallest with 110 amps. Due to the considerable formation of gases and oxides Cr steels could not be welded with non-covered electrodes. Better results were obtained with covered electrodes, but even then the diffusion was not considerable. Diffusion was largest with Cu and Ni, Si and Mn diffused better with non-coated electrodes than with covered ones, whereas with Cu and Ni steel diffusion was better in applying coated electrodes. Author gives in detail his explanations for these occurrences. Diffusion conditions were also studied in welds of 2 layers. The diffusion conditions found were in general substantiated by metallographic examinations. The N content of the welds increased with decreasing welding current, N absorption was larger with non-covered than with covered electrodes. The different behavior of the various steels as regards N absorption is stated. The change of the physical properties of the seams was finally tested by hardness tests. The hardness increased with increasing diffusion. In all welded samples largest hardness was observed in the transition zone between weld and base material. GN (7b)

Technique of Modern Welding. P. BARDTKE. Blackie & Son, Ltd., London. 1933. Cloth, 6 x 8¾ inches, 299 pages. Price 15s. This interesting volume on the technique of modern welding presents in a matter of approximately 300 pages, a tremendous amount of information and data in reference to welding and welding practices, starting in with a brief historical review and going on through fusion welding, outlining very carefully the equipment and apparatus necessary both for the gas and for the arc welding, then considering the welding of various metals, such as steel, cast iron, etc.

The various methods of welding are outlined, or perhaps we should say described, including not only forge welding, resistance welding and spot welding, but also thermit welding. A section is devoted to the application of welding technology and various types of construction to which welding is applied, such as pipe work, airplanes, boilers, buildings, etc. Perhaps one of the best sections is that which has to do with the quality and economics of welding processes. A great deal of the information is presented in the form of curves, but there is also a series of pictures showing the characteristics of arc welding under different conditions such as the current too low or the current too high. Different methods of testing welds are outlined, particularly those without destroying the weld seam.

One of the noticeable characteristics of the book is that the information is given generally in the form of curves showing comparisons between various qualities or the effect of the variation of a single quality. This enables the reader, particularly one unfamiliar with the subject, to perceive readily the relation between the items illustrated as well as the tendency or effect of a single item on the completed job.

This is particularly helpful arrangement. The coordinating of the information makes this book a valuable contribution to the welding industry.

E. W. P. Smith (7b) —8—

Fusion Welding of Rust-, Acid-, and Heat Resistant Steels (Zur Autogenschweissung von rost-, säure- und hitzebeständigen Stählen). HANS MELHARDT. *Der Autogen Schweisser,* Vol. 7, July 1934, pages 99-104. Steels are discussed in 2 groups, (1) Cr steels, (2) Cr-Ni steels. When welding Cr steels the contents in Cr and C must be known. All parts of a martensitic steel which have been heated above 800°C. during welding have to be heat treated. Martensitic Cr steels which are stressed should only be welded at those places where such a heat treatment is possible. Drawbacks (increase in grain size) in welding ferritic Cr steels can be eliminated by heating to above 800°C. and quick cooling. The Cr-Ni steels are austenitic. When these steels are welded carbides segregate at the grain boundaries and intercrystalline corrosion will take place if the steel is not submitted to heat treatment by heating to 1100°C. and subsequent quenching. The technique which should be employed in welding of these steels is discussed in detail. Kz (7b)

Welding Regulations for Buildings, Bridges, and Vehicles. Otto Bondy. *Railway Engineer*, Vol. 55, June 1934, pages 176-178. A comparison between the standard British and German rules for the application of welding is made. Absolute values of permissible stress in fillet welds are specified in the new British regulations (B.55.538) namely 6 tons/in.^{2} for end-fillets and 5 tons/in.^{2} for side fillets, whereas the German rules specify the permissible stress as the permissible working stress in the parent metal. In the case of butt welds, the differences relate only to the amount of the permissible stress. No agreement has yet been reached as to which method is best for computation of fillet welds. In Poland and Belgium the permissible shear stresses are expressed in terms of the permissible shear load (cm. run for end and side fillets). There is no proportionality between fillet thickness and permissible load. In England, end fillets may be loaded up to 5 tons/in.^{2}, or 20% higher than side fillets as compared with 10% according to Polish rules and equal working stresses (65% of tensile stress permissible in parent metal) according to the German DIN 4100. British rules demand that a single V butt weld must be reinforced by a run of weld metal on the back of the V or the maximum permissible stress is reduced 50% in order to counteract possible notch effects (fatigue stresses!). WH (7b)

Strengthening of Railway Bridges by Welding. Otto Bondy. *The Railway Engineer*, Vol. 55, Oct. 1934, pages 313-317. The 6 principal advantages of welding as means of strengthening railway bridges are summarized. Practice has far outstripped theory and research in the strengthening of riveted bridges by welding. Exceptionally heavy responsibility rests upon the designer and a case is described where "strengthening" of a diagonal in a lattice bridge actually resulted in weakening the structure. Restoring strength due to rusting or chemical (saline water dripping from refrigerator cars, neighborhood of chemical plants, etc.) and mechanical causes (loosening of rivets due to repeated stresses) are discussed in full detail. Next cases are taken up where combined reconditioning and strengthening was the object of utilization of welding. Prestressing by application of heat or by hydraulic presses is sometimes made before welding. Important developments in this direction are foreseen and the possibility of utilizing constructionally shrinkage stresses set up by welding is indicated. In the case of combined riveted and welded joints the full weld stress value permitted by the official rules should be utilized. A practical example of strengthening a broad-flange girder by riveting vs. welding is discussed showing the great advantage of the latter method, and examples of strengthening lattice frames are shown. Many practical details can be taken from 27 illustrations. WH (7b)

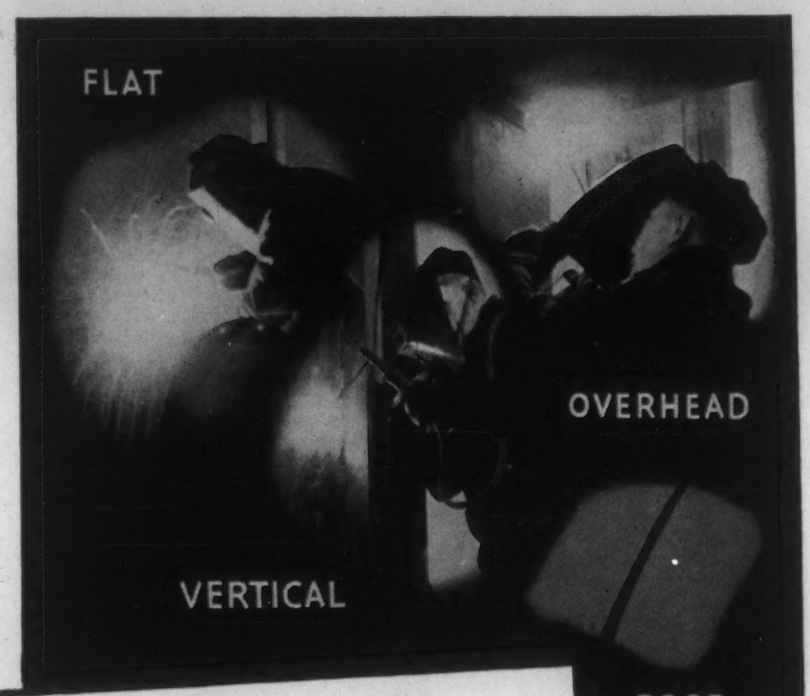
Longitudinal Shrinkage of Longitudinal Welds on Prismatic Parts (Retrait Longitudinal des Soudures Longitudinales sur Pièces Prismatiques). H. Gerbaux. *Revue de la Soudure Autogène*, Vol. 26, Oct. 1934, pages 2-6. Shrinkage is due to 3 causes: (1) Each point of the part undergoes dissymmetrical thermal cycle; heating being much more rapid than cooling. (2) This cycle is dependent upon distance between this point and the seam and appears at various times according to displacement of welding. (3) Mechanical properties of metal vary considerably with temperature (elastic state when cold, plastic state when hot). Shrinkage is the resultant of the 3 causes. Solving the problem involves the following points: (1) Study of heat repartition within time and space. This can be easily determined experimentally. (2) Study of elastic and plastic properties at each temperature. This needs numerous tests for each metal studied. (3) Study of internal stresses and distortions during thermal variations. This is a very intricate matter. Considering following cases: (1) Prismatic part welded along its neutral axis. (2) Prismatic part welded parallel to its neutral axis, the author concludes that a single shrinkage coefficient α easily obtainable experimentally permits solving all problems of longitudinal shrinkage of prismatic parts. FR (7b)

Magnetic Blow Effects in Arc Welding (Magnetische Blaswirkungen bei der Lichtbogenschweissung). Karl Meller. *Die Elektroschweissung*, Vol. 5, Oct. 1934, pages 185-191. A highly disturbing occurrence, known as "blowing" of the arc frequently occurs. The arc blazes back and forth. In part this blazing is due to disturbance occurrences of the heated gases, more, however, due to force effects that are exerted on the arc by magnetic fields. Author discusses in detail the causes and remedies for elimination of this effect. The current lead to the work has a considerable bearing on the blowing of the arc. The arc is always deflected in the direction away from the point of terminal as the author explains by considerations on the distribution of the force lines. Best method to avoid this deflection is to have the current lead arranged at both sides of the weld. If, however, lead is on one side only blow effect can be done away with by oblique arrangement of welding electrode in the direction towards the terminal. Another cause of disturbance is the metal fused. Therefore, blowing will, in general, be due to the simultaneous effect of these various causes. The various remedies are (1) change of lead, (2) suitable position of electrode, (3) decrease of amperage. Paper finally refers in particular to blow effects in welding large plates and to those occurring in automatic welding devices. In the latter case it has been tried to affect deviation of arc by a foreign magnetic field, by arranging a magnetic field either transverse or parallel to the arc. GN (7b)

Remarkable Built-up Welding of a Cast Aluminum Motorblock (Bemerkenswerte Reparaturschweissung an einem Aluminiumguss-Motorgehäuse). Paul Wiessner. *Deutsche Motorzeitschrift*, Vol. 11, June 1934, page 112. Illustrates and describes at great length welding of a 16 x 9 cm. patch into a damaged Al (cast) motorblock. Precautions for shrinkage allowances and heating of the whole work are stressed. WH (7b)

Fusion Welding in Repair of Rolling Stock in Italian State Railway (La Soudure Autogène dans les Reparations du Materiel Roulant des Chemins de Fer de l'Etat Italien). L. Saccomani, A. Foffano & R. Verzillo. *Revue de la Soudure Autogène*, Vol. 26, Oct. 1934, pages 10-15. Paper read at the XIst Congress of Acetylene and Fusion Welding in Rome, June 5-10th 1934. FR (7b)

Dodge Uses Hydromatic Welders in Making All-Steel Bodies. H. W. Roth. *Iron Age*, Vol. 133, June 21, 1934, pages 22-26. Describes the use of special multi-hydromatic machines for welding steel passenger bodies by the Dodge Bros. Corp'n. This method is preferred because it turns out better work of higher uniformity and results in faster, more flexible production. VSP (7b)



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in mild rolled steel, you can procure higher quality welds at faster speed and lower cost with "Fleetweld" electrodes. Heavily coated for shielded arc welding they allow none of the injurious elements of the air to combine with the weld metal to weaken or embrittle it. The physical characteristics of the weld metal produced by each "Fleetweld" electrode are equal to or greater than those of mild rolled steel.

"FLEETWELD 5" welds in all positions producing weld metal with tensile strength of 65,000-75,000 lbs. per sq. in.; ductility of 20%-30% elongation in 2"; impact resistance of 30-70 ft. lbs. (Izod); fatigue resistance of 28,000-32,000 lbs. per sq. in.; density of 7.84-7.86 grams per c. c.; resistance to corrosion greater than mild steel. Welds can be flanged or bent cold, also forged.

"FLEETWELD 6" for flat position welding only. Welds more than meet A.S.M.E. Boiler Code, Class 1 requirements. Welds have approximately 65,000 lbs. per sq. in. tensile strength; average ductility, 25%-35% elongation in 2"; impact resistance, 30-60 ft. lbs. (Izod); fatigue resistance, 28,000-32,000 lbs. per sq. in.; density, 7.85-7.86 grams per c. c.; resistance to corrosion greater than mild steel.

"FLEETWELD 7" for all positions, especially for high speed single pass welding, and where fit-up of work may be poor. Welds show tensile strength of 70,000-80,000 lbs. per sq. in.; ductility, approximately 20% elongation in 2"; impact resistance, 25-30 ft. lbs. (Izod); fatigue resistance, 25,000-30,000 lbs. per sq. in.; density, 7.80-7.85 grams per c. c.; resistance to corrosion comparable to mild steel.

Free samples of "Fleetweld" electrodes are available. Requests for samples should specify type of "Fleetweld" desired.

W-110

THE LINCOLN ELECTRIC COMPANY

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Largest Manufacturers of Arc Welding Equipment in the World

Impurities in the Weld Metal. WILLIAM BARR. *Mechanical World & Engineering Record*, Vol. 95, June 15, 1934, page 569. Abstract of a paper "Some Metallurgical Aspects of the Electric Arc Welding Process," presented to the West of Scotland Iron and Steel Institute. See "The Electric-Arc Welding Process," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 405. Kz (7b)

Changes in the Added Metal in Arc Welds (Alterazione del metallo d'apporto nella saldatura ad arco). L. LOSANA. *La Metallurgia Italiana*, Vol. 26, June 1934, pages 391-401. In arc welds, with bare electrodes there is a great change in the composition of the added metal, the C, Si, and Mn content all being reduced markedly, while S and P change slightly. There is such a strong nitriding, as well as oxidizing action, as to impair seriously the structure of the added metal. In welds with covered electrodes it is possible to control the C and Mn contents fairly well by varying the composition of the covering material. This variation was followed quantitatively for many typical steels. It is difficult to protect completely against nitriding action, however, addition of C to the covering material gives the best results. The N content, however, is always higher than in the original material. With both types of electrodes, the chemical changes vary inversely with the diam. of the electrodes; thus: increasing the diam. reduces the oxidizing, nitriding, etc., actions. The C and Mn contents vary with changes in current density. Bare electrodes give poor welds. Covered electrodes improve the results, but the covering material must be chosen with care. AWC (7b)

Recent Developments in the Welding of the Austenitic Chromium Nickel Stainless Steels. H. HARRIS. *Iron & Steel Industry*, Vol. 7, May 1934, pages 263-264. Chief drawback of the stainless steels of the 18-8 type is their susceptibility to intergranular corrosive attack after being heated to a temperature within the range 400°-800° C. which results in a precipitation of a carbide phase. Lowering the C content of the steel has been suggested as a solution of the problem; this has proven a great improvement although a C content of about 0.06% seems to be the economic limit. Ti addition to the amount 6 times the C concentration less 0.02% has reduced the susceptibility of the steels to intercrystalline attack. It has also been shown that additions of Cb 10 times as great as that of the C offers the most satisfactory solution of the problem. These steels are well adopted to the welding processes as little Cb is lost during welding. Cb-bearing alloy as electrodes for welding of Ti-bearing steels has resulted in remarkably good welds. CEJ (7b)

Fusion Welding in the Construction of the First Pipe Line for Natural Gas in Austria (Der Anteil der Autogenschweissung am Bau der ersten Erdgasfernleitung in Österreich). FERDINAND KORWILL. *Der Autogen Schweisser*, Vol. 7, June 1934, pages 77-78. Application of the oxy-acetylene flame for welding, cutting and bending of steel pipes. Kz (7b)

A Fusion Welding Idyll (Eine schweisstechnische Jdylle). LEO KNEZ. *Der Autogen Schweisser*, Vol. 7, June 1934, pages 80-81. Discussion of the technique employed in the fusion welding of a 3000 kg. church bell. The filler metal used was an alloy containing 78% Cu and 22% Sn. Kz (7b)

Metallurgy of the Fusion Welding of Iron with Special Reference to Nickel-Alloy Welding Material. WILHELM KLEINEFENN. *Iron and Steel Institute, Carnegie Scholarship Memoirs*, Vol. 22, 1933, pages 97-133. Welding with an oxy-acetylene flame, direct and alternating current welding, using bare and coated electrodes, was studied using pure iron-carbon low carbon wires, normal unalloyed wires, and nickel-alloy wires. All agree that heating above the Ac_3, normalizing, improves the welds. With regard to electric welds the author concludes that normalizing has a detrimental effect on the notch toughness when the oxygen content exceeds the limit of solubility of oxygen in α-iron at room temperature. Welds can be rendered proof against aging by using nickel-alloy welding wires, and in the case of direct and alternating current arc welds by using suitably coated nickel alloy electrodes. The hardening effect of precipitation hardening appears to be kept within moderate limits by manganese and nickel. Cementation tests give no clear indication of a good or bad weld mechanically. A comparison between alternating and direct current welds using the same coated electrode shows slight differences due to a slightly greater amount of oxygen absorbed in the alternating current weld. 32 references. CW (7b)

Influence of Cuprous Oxide on the Weldability of Pure Copper (Influence de l'Oxydule sur la Soudabilité du Cuivre rouge). F. GYSEN. *Revue Universelle des Mines*, Series 8, Vol. 10, Aug. 15, 1934, pages 425-428. The equilibrium diagram of the system Cu-Cu_2O shows that Cu_2O dissolves in molten Cu but is entirely insoluble in solidified Cu. The freezing point curve of these alloys has a minimum at 1084° C. for 3.5% Cu_2O. This oxide influences the weld in 2 ways: first by the mechanical interposition of a film of Cu_2O between metal to be joined and added metal; i.e. electrode or welding rod, second by changing the composition of the 2 copper phases together with Cu_3P (P used for deoxidation). The first effect is by far the most dangerous for the soundness of the weld while the second is governed by the amount of P used for deoxidation. By using a flux mixed of NaCl, Na_3PO_4, H_3BO_3, and borax, very sound welds were obtained with up to 90% of the ultimate strength of Cu; the test did not show a trace of Cu_2O in the weld. Best procedure for preparing the work, beveling the edges and adjusting the flame are discussed. Ha (7b)

Distribution of Temperatures and Stresses in Plates Welded by Various Processes (Repartition des Températures et des Tensions dans les Tôles Soudées par Différents Procédés). MAURICE LEBRUN. *Bulletin de la Société des Ingénieurs Soudeurs*, Vol. 5, May-July 1934, pages 1326-1334. Lecture before the *French Welders' Society*. Tests dealt with oxy-acetylene welding, atomic H welding, arc welding. Temperatures measured by thermocouples at various distances from the weld as well as deformation in the shape of holes provided in the plates. FR (7b)

Use of Rolled Steel in Manufacture of Machines (L'Emploi de l'Acier Laminé dans la Construction des Machines). H. G. MARSH. *La Technique Moderne*, Vol. 25, Nov. 15, 1933, pages 753-755. Abstracted by G. Franche from *Engineer*, June 1933. See "The Use of Rolled Steel for Machine Construction." *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 404. FR (7b)

Welding Technique (Was das Handwerk aus der Schweisstechnik für Vorteile ziehen kann). KALISCH. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 29, 1934, pages 461-462. Author first points out the manifold simple applicability of welding and discusses several instances in which welding was applied as, for instance, manufacturing of grates, installation of house pipe lines, heating boilers, automobile repair, etc. GN (7b)

Multiple Operator Welding Sets or Single-Operator Sets—Which? J. L. JONES. *Welding Engineer*, Vol. 19, Sept. 1934, pages 45-47. Present practice prefers single operator sets as the individual welding circuit is less subject to disturbances than the common welding circuits in multiple sets. The latter is recommended only when one motor drives 2 or more generators so that each operator has his own circuit. Ha (7b)

New Constructions of Welding Burners (Neukonstruktionen im Schweissbrennerbau). H. KEMPER. *Autogene Metallbarbeitung*, Vol. 27, Nov. 1, 1934, pages 343-345. A multiflame burner of the Linde Air Products Co. and the Carba burner on rolls for moving along longitudinal seams on pipes, by the Carba A. G., Berne, are described. Ha (7b)

1 **Arc Welding in the Chemical Industry (Die Bogenschweissung in der chemischen Industrie).** P. STRICKER. *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1127-1129. Author reports on the application of electric arc welding in building chemical apparatus and describes several instances as welding of rotating drying ovens, welding the casing of a mill for powdering coal etc. Welded joints are much more stable against corrosion attack than any other type of joint. GN (7b)

— **Autogenous Welding of Aluminum, Magnesium, and Their Light Alloys Using Special Fluxes (La saldatura autogena dell'alluminio, del magnesio, e delle loro leghe leggere con l'uso di speciali fondenti).** L. STIAVELLI. *Alluminio*, Vol. 3, July-Aug. 1934, pages 195-201. Description of trade named fluxes "Rex" and "303" for welding Duralumin and the like, without information on composition of the fluxes. AWC (7b)

2 **Welding With Electrodes Having a Contrasting Analysis to That of the Parent Metal.** MILES C. SMITH. *Welding Engineer*, Vol. 19, Nov. 1934, pages 18-19. Experiments are reported which show that the use of welding rods in arc-welding which are different from the metal to be welded is often advisable. For thin galvanized sheets, an electrode having a core of commercially pure Cu with a mantle or flux covering consisting of a complex plated-on coating of metallic and non-metallic content gave good success. Monel metal electrodes were advantageous for welding cast Fe. High-speed steel could be successfully welded with an electrode containing very small percentages of Cr and V, but no W. In general, it was found that an electrode of different characteristic than the parent metal will give a satisfactory weld as long as the electrode metal will interalloy with the parent metal to form a solid body. Ha (7b)

— **Remarks on Conrady's paper: Atom-Physical Basis of the Phenomenon in the Welding Arc (Bemerkungen zu der Arbeit von H. von Conrady über: Atomphysikalische Grundlagen der Vorgänge im Schweisslichtbogen.** R. SELIGER & H. VON CONRADY. *Die Elektroschweissung*, Vol. 5, Oct. 1934, pages 197-199. Critical remarks on Conrady's former paper in *Die Elektroschweissung*, Vol. 5, Feb. 1934, pages 21-24 (*Metals & Alloys*, Vol. 5, July 1934, page MA 335) from the standpoint of the physicist. Conrady's explanations of the occurrences in the welding arc are doubted. Conrady briefly replies to Seliger's considerations. GN (7b)

3 **Welding Instead of Casting (Geschweisst statt gegossen).** H. SEIDEL. *Autogene Metallbearbeitung*, Vol. 27, Nov. 1, 1934, pages 337-339. Examples illustrate economical manufacture of small intricate parts welded together from elements instead of casting them from a costly pattern when the small number required does not warrant the expense. Ha (7b)

4 **Designing Welded Passenger Train Cars.** L. F. SEELAR. *Railway Mechanical Engineer*, Vol. 108, Nov. 1934, pages 395-398. Practices to be considered are discussed and details of design and preparation of welds for passenger coaches are described. Ha (7b)

— **Welding Specifications for Steel Construction (Vereeniging voor Laschtechniek. Over laschvoorschriften voor staalconstructies).** HANS SCHMUCKLER. *Polytechnisch Weekblad*, Vol. 28, May 31, 1934, pages 338-342; July 19, 1934, pages 449-453. Discusses at great length material, welding methods, calculation of welds, permissible stresses in welded joints, carrying out of welding, qualification testing of welding operators, inspection of welding shops, weld tests according to Kiesskalt-Schweitzer, Hilpert, Schmuckler, effect of dynamic loads according to investigations of Graf-Thum, Schönrock & Bierett, and reinforcing by welded members. WH (7b)

5 **Explanations of the New Specifications for Welded Steel Constructions, 1934 (D I N 4100) (Erläuterungen zu den neuen Vorschriften für geschweisste Stahlhochbauten, 1934 (D I N 4100)).** HANS SCHMUCKLER. *Die Elektroschweissung*, Vol. 5, Aug. 1934, pages 153-158; Sept. 1934, pages 171-177. In the first instalment of the paper author critically discusses the new German specifications referring to (1) materials, (2) welding methods, (3) calculation of weld seams, (4) admissible loading of weld seams, (5) testing of welders, (6) constructional design, (7) welding performance, (8) supervision and testing of welding work. In the second instalment a number of examples showing the application of the new specifications to the constructional design and the calculation of the most important weld joints are given. GN (7b)

— **Electrically Welded Tanker "Peter G. Campbell" (Elektrogeschweisster Tankleichter "Peter G. Campbell").** R. SCHMIDT. *Werft, Reederei & Hafen*, Vol. 15, May 15, 1934, pages 122-124; June 1, 1934, pages 132-134. Polemic against statements of N. M. Hunter & W .J. Lovett at the Meeting of the North-East-Coast Institution of Engineers & Shipbuilders on the present state of electric welding in Great Britain as compared with Germany and the U. S. A. The advancements in England as manifested in the latest electrically welded tanker "Peter G. Campbell" are discussed in full structural details, which can also be taken from 14 illustrations. The paper also includes discussion of Bennett, Lilierap, Adam, Spanner, Liddell, Hovgaard, Akester, Townshend, Drake on various problems connected with electric ship welding. WH (7b)

6 **Under-water Arc Welding (Unterwasser-Lichtbogenschweissung).** R. SCHMIDT. *Werft, Reederei & Hafen*, Vol. 15, Aug. 1, 1934, pages 203-205. Based on statements of Hibshman, Jensen & Harvey before the Autumn Meeting of the American Welding Society, 1933, Schmidt points out the great significance of subaqueous welding for the ship-builder due to the absence of warping, harmful gases particularly of N_2, and the remarkable physical properties of low C steel welds made under water. Schmidt suggests welding in shipyards under-water. WH (7b)

— **Improving the Quality of Spot Welds.** A. M. MACFARLAND. *Welding Engineer*, Vol. 19, Nov. 1934, pages 15-17. The factors governing the quality of a spot weld are amperage and timing of the welding current, conditions of the points, pressure imposed during welding operation, condition of the surfaces to be welded, whether they are warped and affect the contact; these factors must be kept uniform during the welding process to obtain satisfactory welds. Methods and equipment for his purpose are reviewed. Ha (7b)

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Efficient Jigs Fabricated From Steel. F. HARTLEY. *American Machinist*, Vol. 78, Nov. 21, 1934, pages 802-803. Examples illustrate how steel plates can be cut and welded cheaper and quicker to make up jigs and fixtures than by waiting for pattern maker or foundry. Ha (7b)

Further Results on Research into Electrically Welded Joints of Ship Members (Weitere Forschungsergebnisse mit elektrisch verschweissten Schiffskörperverbindungen). B. P. HAIGH. *Werft, Reederei & Hafen*, Vol. 15, June 1, 1934, pages 137-318. Paper before the Spring Meeting of the Institution of Naval Architects, London, March 21-23, 1934 critically discusses the new structural principles introduced into ship-building by welding in comparison with riveting, and the restrictions in translating the experiences gained on small all-welded ships into larger ones. Reports on extensive tests with structural members jointed by riveting and welding and submitted to compressive and tensile stresses. The superiority of welded symmetrical profiles has been established. Includes also discussion of King, Varty, Lillicrap, Pengelly, Spanner and Whiting. WH (7b)

Problem of Welding Copper (Das Problem der Kupferschweissung). P. M. GRAUPE. *Metallwaren Industrie & Galvanotechnik*, Vol. 32, May 15, 1934, pages 213-215. Discusses the precautions which counteract the inherent deficiencies of welding Cu, namely its great affinity towards O and H, high thermal conductivity and high heat of fusion in comparison with Fe. Ordinary Cu wire may be used as filler rod for welding Cu, but improved physical properties are secured with the Canzler filler rod which contains P and Ag. Welding on both sides of the parent sheets according to Weese is considered and the latter's suggestions regarding terminology are discussed. EF (7b)

Metallic-Arc Welding of Grey Cast Iron. G. NYQUIST. *Welding Engineer*, Vol. 19, Nov. 1934, pages 23-24. To obtain good welds on cast Fe the effect of C on cast Fe during the welding process and action of expansion and contraction must be taken into account. Methods to avoid hard spots due to C precipitation and fracture are explained. Ha (7b)

A Glimpse at Welding in the Mexican Republic. L. C. MONROE. *Welding Engineer*, Vol. 19, Nov. 1934, pages 20-21. A brief review of applications of welding methods in the oil, mining and other industries, shop work, and general organization of welding gangs. Ha (7b)

Weldability of Steels of Higher Strength (Schweissbarkeit von Stählen höherer Festigkeit). J. MÜLLER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Nov. 3, 1934, pages 1293-1294. Fusion welding of sheets of 0.5-3 mm. of high strength as used in aeroplane construction often results in cracks directly beside the weld; it is due to welding stresses, defects of material or welding rod, or wrong procedure. Furthermore, the weld is often so hard that it is difficult to machine or work it further. This hardness and the tendency to crack have no relation to each other. The tests seem to point to the fact that in order to avoid cracking the content of P + S which was (according to German rules) limited to 0.07%, is still too high, and that C should not be higher than 0.27%. Si and Mn have apparently no influence in this respect. Ha (7b)

Arc Welding for Bridge Construction. LAMOTTE GROVER. *Civil Engineering*, Vol. 4, July 1934, pages 360-364. Paper read before the Kansas State Section of the American Society of Civil Engineers. Outstanding characteristics governing the design of welded structures are reviewed, the most important being the rigidity of the weld and the presence of residual stresses. Covered electrodes give strongest welds. Brief details of some all-welded bridges are listed. JCC (7b)

Fusion Welding in Motor Car Manufacture (La Soudure Autogène dans les Constructions Automobiles). R. GRANJON. *Revue de la Soudure Autogène*, Vol. 26, Sept. 1934, pages 14-15. Condensed review of present practice showing the part played by each kind of welding in the modern motor car manufacture. Despite the progress made it is pointed out that coöperation between automotive engineers and welding engineers could be much closer and beneficial. Large knowledge of weldability is needed for studying any new problem arising in manufacturing work and for controlling all phenomena met with in welding operations. Too often one method of welding only is used in one shop whereas it is logical to resort to one well defined kind of welding for each type of work. FR (7b)

Welded Steel Arch of 166-ft. Span in Czechoslovakia. FRANTISEK FALTUS. *Engineering News-Record*, Vol. 113, Nov. 8, 1934, page 593. One of the largest welded bridges yet undertaken has an all-welded arch. CBJ (7b)

Welding Used Extensively in Tall Apartment House in Poland. STEFAN BRYLA. *Engineering News-Record*, Vol. 113, Oct. 25, 1934, pages 524-525. The tallest apartment house in Poland and the second highest in all Europe was constructed with its structure arc-welded in the shop and riveted in the field. CBJ (7b)

Welding. J. E. BOTTOMLEY. *Journal Institution of Locomotive Engineers*, Vol. 24, July-Aug. 1934, pages 588-610. Includes discussion. Paper read before the Bombay branch of the Institution. A general account of ferrous welding practice in the Parel shops of the G. I. P. Railway. JCC (7b)

Underframes for D. L. & W. Diesel-Electric Locomotives. F. H. BREHOB. *Railway Mechanical Engineer*, Vol. 108, Nov. 1934, pages 393-395. The underframe carrying the Diesel engine and the dynamo is welded together of standard shapes and plates; it weighs 28,000 lbs. and carries a load of 128,000 lbs. Ha (7b)

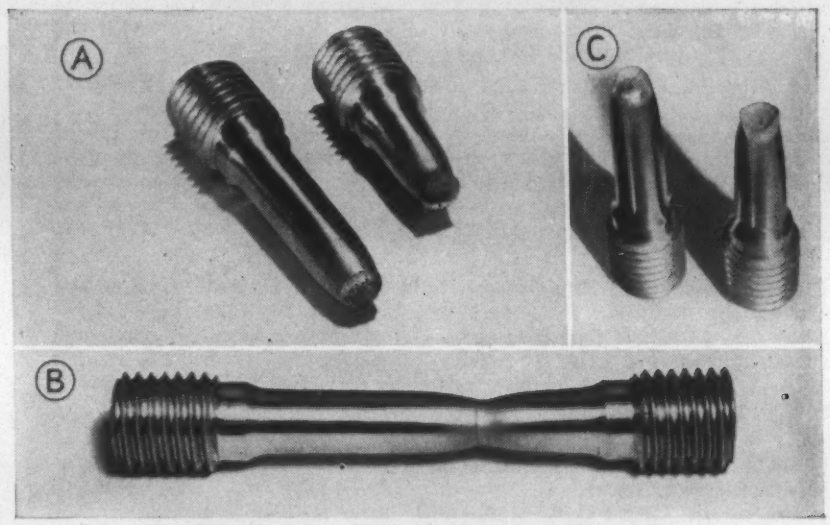
Flame Machining—Its Effect on Steel. ERNEST E. THUM. *Metal Progress*, Vol. 24, Dec. 1934, pages 35-39. Reviews papers presented at 35th Convention of International Acetylene Association, Nov. 1935. Cutting the central discard from wing type ingots for reducing discard metal in steel mill practice, cutting of plates, beams and slabs to various shapes are described. A paper showing that acetylene cutting of steel produces no damage to quality and one describing the use of acetylene torch for billet preparation are reviewed. Torch preparation has been found so economical that it has replaced chipping in one seamless tube mill. WLC (7b)

CROMANSIL STEEL

Chemical Analysis		Physical Properties	
Chromium	.47%	Tensile Str.	81,400 p.s.i.
Silicon	.77%	Yield Point	55,800 p.s.i.
Manganese	1.26%	Elongation in 2"	22%
Carbon	.14%		

CROMANSIL STEEL

WELD METAL



PHOTOS A & B: PHYSICAL PROPERTIES

Tensile Strength—99,500 p.s.i. Yield Point—93,500 p.s.i.
Elongation in 2"—21%

PHOTO C: PHYSICAL PROPERTIES

Tensile Strength—80,500 p.s.i. Yield Point—74,750 p.s.i.
Elongation in 2"—26%

Murex Mineral Coated Electrodes make it easy to obtain weld metal to fit almost any specified requirement. One Murex Electrode, for example, deposits weld metal closely matching the Cromansil steel above . . . an important factor where welds are subject to dynamic stresses and fatigue. Another, used to weld higher strength Cromansil steels, provides tensile strengths of approximately 100,000 p.s.i. with ductility of 21% in 2 inches.

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8. FINISHING

H. S. RAWDON, SECTION EDITOR

Enameling Forges Ahead as a Metal Finish. LE ROY W. ALLISON & MALCOLM B. CATLIN. *Iron Age*, Vol. 133, June 21, 1934, pages 14-19. **Wet and Dry Processes of Enameling.** *Iron Age*, Vol. 134, July 5, 1934, pages 18-21. Enameling of sheet steel and cast Fe is considered. Preparation of the metal for enameling and notable advances in the fields of applications are discussed. Second installment considers the wet and dry processes and their expanding range of usefulness. VSP (8)

How Attractive Finish Helps Metal Products Sales 13—Polishing and Buffing. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, Mar. 15, 1934, pages 16-19. Presents some of the important features of the art and shows how established principles of manufacturing practice may be applied to polishing and buffing to reduce costs and obtain results more nearly suited to requirements. VSP (8)

How Attractive Finish Helps Metal Products Sales. 19. Coloring Aluminum. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, June 14, 1934, pages 18-21. Describes an unusual method of coloring Al products by dyeing an oxide coating on the surface. The oxide coating of average thickness is produced in about 20 min. and becomes an integral part of the metal. Cigarette cases, pencils, cafeteria trays, etc., are typical products made from this material. Process was commercialized by the Aluminum Colors Co. VSP (8)

Attractive Finish Helps Metal Products Sales. 17. Pre-Finished Raw Materials. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, May 10, 1934, pages 17-20. Discusses the features of production and use of pre-finished materials. Large-scale standardized production makes for economy in plating department. Use of pre-finished sheets is less expensive than maintaining a plating department. Likewise pre-lacquering has its advantages. VSP (8)

Finishing and Testing of Aluminum Castings (Das Fertigmachen und Prüfen von Aluminiumgussstücken). E. BECKER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Oct. 28, 1934, pages 455-456. Author discusses sand blasting, brushing, pickling, grinding and polishing of Al alloy castings together with reference to methods of testing density of Al castings. GN (8)

8a. Pickling

Pickling of Iron and Steel. H. G. HOBBS. *Iron Age*, Vol. 133, May 3, 1934, pages 9, 72, 74, 76, 78. **Today's Pickling Practice in Iron and Steel.** *Iron Age*, Vol. 133, June 14, 1934, pages 12-15, 68. From a paper read before the Association of Iron and Steel Electrical Engineers, Youngstown Meeting, April 1934. Deals with modern pickling equipment and proper procedure. VSP (8a)

A New Technique in Acid Handling. J. R. HOOVER. *Iron & Steel Engineer*, Vol. 11, June 1934, pages 215-218. Read at Youngstown Meeting, Association of Iron & Steel Electrical Engineers, Apr. 1934. Describes Vulcalock Process (rubber bonded to steel) for protection of steel pickling tanks. WLC (8a)

8b. Cleaning, including Sand Blasting

Blast Cleaning of Steel. W. A. ROSENBERGER. *Iron & Steel Engineer*, Vol. 11, Aug. 1934, pages 286-296. Read and discussed at Youngstown Meeting, Association of Iron and Steel Electrical Engineers, Apr. 1934. WLC (8b)

Cleaning of Steel. E. A. RICH. *Iron & Steel Engineer*, Vol. 11, Aug. 1934, pages 284-286. Read and discussed at Youngstown Meeting of Association of Iron and Steel Electrical Engineers, Apr. 1934. Describes abrasive cleaning methods without the use of compressed air. WLC (8b)

A New Process for the Cleaning of Metals. U. C. TAINTON. *Wire & Wire Products*, Vol. 9, Nov. 1934, pages 399-400. The absolutely clean surface which is needed for electroplating of metals is obtained by immersing the article in a bath of fused sodium salts in which the nascent metallic Na during electrolysis produces in a few seconds a more completely continuous clean metal surface with no metallic inclusions than can be obtained by pickling. The process has the economical advantage of using no acids therefore eliminating the problem of disposing of waste acid; furthermore, loss of metal is practically eliminated. Steel is not embrittled through absorption of H, and can even be tempered while being cleaned. No preliminary degreasing is necessary. The method can in many cases replace sandblasting. Steel cleaned in this manner unlike steel cleaned by pickling, can be stored without rusting. The cost is about 25-50c per ton of metal treated; 5-20 kw.-hr. with 5-10 lb. of soda per ton of metal are required. Ha (8b)

8c. Polishing & Grinding

Fundamentals of Grinding and Polishing (Grundsätzliches über Schleifen und Polieren). *Metallwaren Industrie & Galvano Technik*, Vol. 32, Jan. 15, 1934, pages 30-32; Feb. 1, 1934, pages 48-49. In discussing grinding raw materials, Si-carbide is taken as an example in referring to grain size, binding agent, hardness, structure of grinding wheel. Balance of paper discusses the following polishing materials: Al oxide, SiO_2, diatomaceous earth, pumice stone, Spanish white, polishing lime, rouge, Cr oxide. EF (8c)

Roughness and Modern Methods to Record the Profile of Surfaces (Note sur la Rugosité et les Méthodes modernes utilisées pour relever le Profil des Surfaces). E. BODART. *Revue Universelle des Mines*, Vol. 10, Oct. 15, 1934, pages 544-553. An effort is made to define roughness and unevennesses of surfaces as deviations from the ideal mathematical surface; a mathematical expression is derived, and methods used at present to study and compare profiles and polish of surfaces are discussed. The exactness with which a surface approaches the mathematical surface by grinding and polishing depends largely on the polishing agent. Besides the mechanical and optical methods to determine the deviation from the true (plane, cylindrical or spherical) surface the method of making a mold of the surface in some plastic material can be used especially in cases where, on account of the shape or size of the piece the other methods are not practicable. The mold is sliced with a microtome into slices of a thickness of 7-12 microns which were observed under the microscope. On comparing the same surface molded in 3 different plastics it was found that with gelatine-glycerin differences in height of the irregularities can be measured with an accuracy of about 4.3%, with celloidine of 13%, and with durofix of 2%. 6 references. Ha (8c)

8d. Electroplating

Chromium Plating—Its Mechanical Application. Machinery's Yellow Back Series. Machinery Publishing Co. Ltd., London. 1934. Paper, 5 x 8½ inches, 54 pages. Price 2/6d.

This booklet is a very useful compilation of the mechanical applications of chromium plating, that will be valuable to every person who has occasion to consider such problems. It gives typical results obtained in various applications, such as on gages, reamers, drills, milling cutters, lathe tools, woodworking tools, dies, rolls, bearing parts of machinery, and printing plates.

Precautions required to secure uniform distribution are clearly explained, and the operation of the baths is described, as well as the physical properties of chromium. The discussion of the bath composition, temperature and current density is less specific than would be necessary to permit a reader to duplicate any set of conditions. American readers should note that (presumably) the concentrations are given in ounces per Imperial gallon (although the reference to Sargent corresponds to ounces per U. S. gallon).

While many of the statements are qualitative and subject to valid differences of opinion, the book is almost free of specific errors. One apparent mistake is a reference (page 49) to the use of a chromium wire as the anode in plating rifle barrels. In the reviewer's opinion it is more probable that the resistance of chromium to wetting and to adhesion to metal surfaces, is caused by the passive oxide film rather than by "the high surface energy of chromium" (page 22).

The compilers are to be congratulated for compressing so much useful information into so small a space. William Blum (8d) —B—

Gold Plating of Aluminum (Die Vergoldung des Aluminiums). WERNER FRÖHLICH. *Die Metallbörse*, Vol. 24, Sept. 8, 1934, pages 1146-1147; Sept. 15, 1934, page 1179. Successful electro-deposition of Au, Ni, Cu, Zn on Al is readily obtained on an oxide-free rough surface, although recent investigations indicate that the firmest bond is secured on a highly polished surface. Sandblasting does not furnish a suitable roughened surface and blasting with steel dust is too severe. After degreasing, chemical pickling is applied. Usual HNO_3-HCl mixtures are entirely unsuitable for Al. Mixture of 500 parts HCl, 500 parts H_2O and 1 part Fe is recommended. Pickling is finished when the Al surface appears dull. Overpickling must be avoided otherwise polishing of the Au coating is necessary. An intermediary Ni layer is sometimes used. Electrolyte: 50 g. Ni chloride, 20 g. boric acid/liter H_2O; or 72 g. Ni salts, 24 g. $NaNO_3$, 6 g. $MgSO_4$/liter H_2O. Anode: cast Ni; voltage = 2-2.5 volts; time = 20 min. An intermediary brass layer is also suitable. Method: degreasing with 15 g. borax, 8 g. soda, 2 g. caustic soda, 2 g. NH_4Cl/liter H_2O. Temperature = 90°-93° C.; time = 1 min. Pickling solution: 1 liter H_2SO_4, 1 liter H_2O, 15 g. $FeCl_3$ + 60 cc. H_2O. Temp. = 21° C., time = 20-25 sec. Brass plating solution: (1) 15 g. Cu cyanide, 3.8 g. Zn cyanide, 22.5 g. Na cyanide, 15 g. K hydroxide/liter H_2O; temperature = 21° C., electrodes = cast brass plates. (2) 18 g. Cu cyanide, 6 g. Zn cyanide, 30 g. Na cyanide, 6 g. Na bicarbonate, 3 g. NH_4Cl/liter H_2O, temperature = 25° C., 4 volts. Gold plating solutions: (1) 3 g. Au chloride, 3 g. Na cyanide, 3 g. Na phosphate, 1.5 g. Na bisulphate/liter H_2O; temperature = 60° C., potential = 2.5 volts, anodes = Au sheets. (2) 2-3 g. Au (tri) salt, 75 g. Na cyanide, 1.5 g. Na phosphate/liter H_2O, temperature = 70°-80° C.; 2 volts. EF (8d)

Production of Bright Electrolytic Nickel Deposits in Presence of Colloids (Obtention de Dépôts Electrolytiques de Nickel Brillants en Présence de Colloïdes). MARCEL BALLAY. *La Technique Moderne*, Vol. 26, Aug. 15, page 571. Short abstract from a lecture at the *Académie des Sciences*, June 25, 1934. See "Production of Bright Electrolytic Deposits of Ni in Presence of Colloids," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 526. FR 8d)

Industrial Chromium Plating—9 and 10. D. A. NEMSER. *Iron Age*, Vol. 133, Feb. 1, 1934, pages 14-15, 76; Feb. 8, 1934, pages 18-20. Review of progress and practice in the art of industrial Cr plating. First instalment deals with properties of Cr plate applied for decoration and for wear-resistance. Second instalment gives valuable data on applying Cr to cutting tools, dies, rolls, gages, etc. Marked increase in length of life by means of Cr-plating and replating is claimed. VSP (8d)

Chromium Plating Literature. XXIX, XXX. L. H. DECKE. *Platers' Guide*, Vol. 30, Sept. 1934, pages 25-27; Nov. 1934, pages 17-18. These instalments dealing with health hazards summarize a study in 6 Cr-plating plants of 23 workers with known occupational history. 20 conclusions and recommendations are listed. WHB (8d)

How Attractive Finish Helps Metal Products Sales. 23.—Copper Plating. MARSHALL G. WHITFIELD. *Iron Age*, Vol. 134, July 26, 1934, pages 27-29. The commonly used bath for Cu plating of steel is cyanide Cu bath. It is used exclusively for the initial plating of Fe and steel. A recently developed bath to replace cyanide bath contains a double salt; Cu Na oxalate as its main constituent. This eliminated the hazard connected with the use of cyanide. Proper surface preparation is of great importance. Best thickness of Cu coating is 0.001" for outdoor exposure. Heat treating heavily Cu-plated sheet in reducing atmosphere increases its corrosion resistance. Comparison with other coatings is given. VSP (8d)

Distinction Between Mechanical and Electro-Deposited Gold Coatings (Zur Unterscheidung von Doublé und Galvanogold). E. RAUB. *Metallwaren Industrie & Galvano Technik*, Vol. 32, Mar. 15, 1934, pages 115-118. Glocker & Dehlinger showed that a distinction between electro- and mechanical Au platings is possible by X-ray methods and Raub shows that microscopic examination is also feasible. The sample is prepared by first Cu plating in a Cu cyanide and then in acid electrolyte and a cross section of the plated sample is prepared in usual manner and etched with conc. HNO_3. The electro-deposited Au coating remains unattacked. Soldered joints are particularly suited for inspection since electro-deposition is carried out after the joining operation. The doublé (rolled-on) Au coating is discontinuous at the soldered joint. The coating formed by electro-plating is not of uniform thickness especially on irregular objects, whereas the mechanical plating is uniform in spite of shaping processes. EF (8d)

Effect of Iron on the Efficiency of Chromium Plating Solutions (Die Wirkung des Eisens auf die Leistungsfähigkeit der Chrombäder). OSCAR KRÄMER. *Metallwaren Industrie & Galvano Technik*, Vol. 32, June 15, 1934, pages 262-263. The decreased throwing power of Cr electrolytes with rising Fe concentrations is demonstrated experimentally. A temperature-current density diagram illustrates how the bath conditions under which light Cr platings are possible are affected detrimentally by the presence of Fe. It is claimed that Cr plating solutions can be regenerated, in which case they may be used for years. EF (8d)

Cadmium Plating (Galvanisches Verkadmien). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Oct. 14, 1934, page 647. Suitable composition of Cd plating baths is discussed and the advantages of Cd platings in particular their high corrosion protective properties are outlined. Gn (8d)

8e. Metallic Coatings other than Electroplating

Galvanizing, Means of Protection of Ferrous Metals against Atmospheric Corrosion (La Galvanisation, Moyen de Protection des Métaux Ferreux Contre la Corrosion Atmosphérique). M. LÉPINGLE. *Science et Industrie*, Vol. 18, Apr. 1934, pages 110-115. Some results of practical application, tests on thin sheets, and other tests are given. FR (8e)

Zinc for Steel Protection—II. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, Mar. 22, 1934, pages 12-14. A partial answer to certain questions raised in previous article, (*Iron Age*, Nov. 16, 1933, pages 13, 56). Discusses factors such as relative protective value of Zn alloys vs. pure Zn, best thickness of coating for certain applications and improvement of bond of Zn with basis metal. Electroplating and hot-dip galvanizing are compared. VSP (8e)

Metal Spraying Gains in Mexico. C. E. DE VRIES. *Metallizer*, Vol. 3, Oct. 31, 1934, page 5. All meter boxes of Mexican Light and Power Co. are to be lined with zinc by metal spraying. Results of erosion tests were satisfactory. Other applications of metal-spraying described are: zinc-coating an oil tank car, a glycerine filter and tire rims, brass-coating a paper mill roll, aluminum-coating a glue cutting machine and metal statue, monel-coating a chemical mixing tank and repairing a cracked motor head by spraying with low carbon steel BWG (8e)

Complete Report for the Oil Industry on Aluminum Coating of Pressure Vessels. *Metallizer*, Vol. 3, Sept. 30, 1934, pages 8-11, 13. Discussion of the procedure, equipment, costs and applications of sprayed aluminum in oil refineries based on field experience. The surface is prepared by sand blasting after removal of adhering coke and oil in seams with a gas torch. A second thorough sand blasting with sharp +14, —9 mesh sand is given to about 50 ft.² and this area coated with Al 0.015"—0.016" (3½—4 oz./ft.²) before proceeding further. A heavy coating, as over 0.020", may develop stresses which weaken the bond. Cost of complete equipment, including metallizing gun, is given as $602.35, with $220.70 extra for a 600-lb. sand blast generator and accessories. With labor at $0.75/hr., cost per sq. ft. of coating an average vessel with Al is estimated at $0.52, of which $0.08 is for the first and $0.13 for second sand blasting. BWG (8e)

8f. Non-Metallic Coatings

Rust Protecting Power of Cadmium Cyanamides (Die rostschützende Wirkung des Kadmiumzyanamids). E. LIEBREICH. *Farbe und Lack*, Oct. 11, 1933, page 488. The beneficial effect of K, Na and Cd cyanamides as addition to primer coats on Fe was previously ascribed to the formation of hydrides. More recent tests revealed the occurrence of NH_3, which binds the moisture diffusing through the paint coating. This effect is most pronounced with Cd-cyanamide. EF (8f)

Prefinished Sheets Extend Design Limits. HAROLD B. VEITH. *Machine Design*, Vol. 6, Nov. 1934, page 27. Discusses steel sheets on which the finish coatings have been applied before the material goes into processing operations. Instrument panels, automobile window trims for instance are formed, stamped, and cut from sheets on which a film of synthetic veneer has been applied previously. Covering the metals with such designs as inlays gives the appearance of expensive cabinet work. 4 or 5-color combinations are now available. Tests show remarkable resistance of this type of pre-finished steel sheets to heat, cold, salt spray and ultraviolet ray. Commercial utilizations are briefly considered. WH (8f)

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Fast-Drying Lacquers of Synthetic Raw Materials (Schnelltrocknende Lacke aus Künstlichen Rohstoffen). H. HEBBERLING. *Oberflächentechnik*, Vol. 11, June 3, 1934, pages 143-144. New kinds of lacquers and varnishes are made of copal-like synthetic resinous substances with fast-drying China wood oil. Whereas natural copals are miscible in oils only after a long boiling and melting process, the artificial products can be treated directly with linseed and wood oil. These lacquers are preferably used for inside purposes as they are not very resistant to sunlight although they resist water and chemical action well. Although they dry in 4 hours, a longer time is recommended for durability. Ha (8f)

Renovation of Old Paint on Apparatus (Erneuerung alter Apparateanstriche). H. HEBBERLING. *Werkstoffe und Korrosion*, Vol. 9, July 25, 1934, page 25. Paint on wood and metal parts should be cared for as soon as the first sign of deterioration is evident; if the deterioration is far advanced it should be renewed entirely. In any case, rust on iron parts must be carefully removed before the new paint is put on. Ha (8f)

Rust Inhibiting Pigments (Rostschutzpigmente). A. V. BLOM. *Farben Zeitung*, Vol. 39, July 14, 1934, page 728. The inhibitive action of certain pigments on corrosion has been ascertained definitely by Cushman & Gardner, Lewis & Evans, Ragg & Riedemann. Results of Lewis & Evans (Jour. Soc. Chem. Ind., London, Jan. 1934) are reviewed. Shaking tests in which bare steel sample 1 x 3 cm. with 1 cc. pigment and 3 cc. of corroding medium were shaken 20 hrs. at 25° C. in a closed glass bottle gave the following order of merit in regard to the average protective power of pigments against 4 different media (dist. H_2O, .001 M sols. of NaCl, H_2SO_4, Na_2SO_4)

		Loss in weight in 0.0001g	Attacked surface %
Pb peroxide	(PbO_2)	133	38
No pigment		89	37
Pb suboxide	(Pb_2O)	47	35
red lead	(Pb_3O_4)	24	4
litharge	(PbO)	3	0
pigment N		1	0

In order to obtain results applicable to paint coatings, Lewis & Evans tested steel samples which were coated with the pigments suspended in linseed oil. The coatings were scratched in order to expose the steel and tested in the same solutions. The order was confirmed. Litharge which cannot be incorporated in linseed oil by ordinary methods was omitted. Pb peroxide stimulates rusting. Blom claims that the much disputed theory that the PbO_2 in Pb_3O_4 (red lead) is responsible for its rust inhibiting property is completely disproved, he says that the content of litharge (PbO) in red lead accounts for the latter's rust inhibiting power. In pigment N a suspension of litharge was secured by a special chemical treatment (Swiss patent 125969). Results are cited to show the superiority of pigment N over red lead. In general, the tests developed by Evans and his coworkers are highly commended as a means for studying the rust inhibiting properties of new pigments. EF (8f)

Black Coatings on Copper, Copper-Plated Metals or Copper Alloys (Herstellung tiefschwarzer Überzüge auf Kupfer, verkupferten Metallen oder kupferhaltiger Legierungen). *Metallwaren Industrie & Galvano Technik*, Vol. 32, Apr. 30, 1934, pages 189-190. Coloring solution is 5% NaOH + 1% K-persulphate. Temperature = 100° C., time = 5-7 min. If the time of treatment is extended too long, a loose brown coating results. K-persulphate must be replenished regularly. Degreasing and pickling in diluted H_2SO_4 furnish the necessary clean surface. Dilute HCl or NaOH solutions are unsuitable. Zn, Sn, Al, brass and objects low in Cu must be Cu-plated first. NH_3, CO_2 O_2, N_2 and H_2O do not readily affect the black color. EF (8f)

9. TESTING

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Internal Stresses. Parts III, IV, V. CHARLES S. BARRETT. *Metals & Alloys*, Vol. 5, Aug. 1934, pages 170-174; Sept. 1934, pages 196-198; Oct. 1934, pages 224-226. For abstracts of Parts I and II see *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 451 and Nov. 1934, page MA 543. Part III. Though spots on Debye rings may be related to surface, unidirectional stresses confirmation is wanting and no relation established regarding 2 or 3 dimensional distribution. Width of lines in powder diffraction patterns is discussed. Crystal recovery sharpens lines, recrystallization and grain growth make spotty lines. The relation of line width to type and amount of deformation and to fatigue are still somewhat obscure, and the relation to hardness is controversial. Part IV. Since dimensions of crystal lattice are altered in same proportion as external dimensions, X-ray methods are capable of measuring surface stresses; accuracy is 2000 to 5000 lbs./in.^{2} Distribution of stresses below the surface is not disclosed. Relative intensity of diffraction in different orders is altered by plastic deformation even in metals that do not show strain widening of diffraction lines. Theory relates the effect to changes in the electron distribution in deformed metals. Absolute intensity of diffraction is altered in perfect crystals such as quartz by elastic stress but not appreciably in less perfect metal crystals. Part V. Discusses relation of internal stress to season cracking, quenching stresses, fatigue and other mechanical effects. WLC (9a)

Novel Testing Apparatus for Tube Welds (Über ein neues Prüfgerät für Rohrschweissnähte). J. F. KESPER. *Die Wärme*, Vol. 57, Sept. 15, 1934, page 604. The illustrated non-destructive tube weld tester utilizes compressed air. It is pushed on rolls into the tube under test and the weld section (circumferential weld) is hermetically sealed off by inflated rubber tires guided by steel plates. The rubber cushions are naturally inflated to a higher pressure than the pressure in the weld section. EF (9a)

Rapid Testing of the Characteristics of Metallic Coatings. ALEXANDER GLAZUNOV. *Iron Age*, Vol. 134, July 5, 1934, pages 12-14. Includes references. Author develops an electrolytic method of testing coated wires. Method consists in submerging a measured length of wire in a concentrated electrolyte, a slightly acidified solution of a simple salt of metal used in coating the wire. Sample is connected to positive end of battery (voltage of 4 to 8). Cylindrical negative surrounds sample. After pure metal of coating goes into solution the intermediate gradation alloys of coating are exposed. Anodic potential will change and current decrease. After dissolving of gradation alloys the original metal is exposed. Exact thickness of coating may be calculated from electrochemical equivalent, sp. gr. and diam. of tested wire. VSP (9a)

Some Practical X-ray Developments. *The Railway Engineer*, Vol. 55, Oct. 1934, page 299. High voltage X-ray radiography is difficult for steel sections over 3 in. thickness. Gamma ray equipment is easily portable. Oxidation of grain boundaries in special steels is not detected by X-rays. The latter are useful in detecting fissures without destruction. For steel sections thicker than 3", gamma rays are cheaper than X-rays. Tests with X- and gamma rays are under way which will reveal the composition of the metal at the weld. WH (9a)

Mesothorium (Mesothorium). MAX WOLF. *Die Umschau in Wissenschaft & Technik*, Vol. 38, Oct. 7, 1934, pages 817-822. Reviews chemical preparation and utilization for medical and technical purposes. 1 g. Ra costs 210,000 R.M. as compared with 80,000 R.M./1 g. of mesothorium. With reference to the same radiation effect, mesothorium costs 130,000 R.M. WH (9a)

X-ray Inspection of High Alloy Castings. F. K. ZIEGLER & D. W. BOWLAND. *Metal Progress*, Vol. 24, Dec. 1934, pages 22-26. Describes the improvements in foundry product resulting from the use of X-ray inspection by one familiar with radiography and casting defects and the correlation of radiographic study with sectioned castings and service records. Interpretations of several markings on X-ray negatives are discussed. WLC (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Shot and Arc Welding of Stainless Steel (Die Schnellpunkt- und Licht-bogenschweissung von rostsicheren Stählen). WERNER HOFFMANN. *Die Elektroschweissung*, Vol. 5, Oct. 1934, pages 181-184. After reviewing literature on this subject author discusses results of his experiments. The physical properties of spot welds of austenitic Cr-Ni-Ta steel sheets that had been cold rolled in 6 passes from 1 to .1 mm. were investigated. It was found that with thin sheets higher tensile strength and smaller loss of elongation was attained in applying higher reduction in the first passes. These sheets were spot welded with a shot welding machine of latest design as built by Allgemeine Elektrizitätsgesellschaft, Berlin. In the tensile tests fracture always occurred outside the weld seam and outside the heat affected zone. Microstructure of such shot welded sheets are shown. The fatigue limit of shot welds of austenitic Cr-Ni steel of about 100 kg./mm.^{2} tensile strength amounts to about 25 kg./mm.^{2} Arc welds of a steel with .1% C, 18.2% Cr, 8% Ni and 1.3% Ta gave the following physical properties: tensile strength: 62.5 kg./mm.^{2}, yield point: 34.8 kg./mm.^{2}, elongation: 50-40%, notch toughness: 25.5 mkg./cm.^{2}, bending angle: 180°, fatigue limit: 26 kg./mm.^{2} Corrosion tests proved absolute insensitivity towards corrosion. GN (9b)

The Hardness of Metals and its Measurements. HUGH O'NEILL. Chapman & Hall, Ltd., London, 1934. Cloth, 6¼ x 9¾ inches, 292 pages. Price 25s.

Here is a book of 292 pages devoted exclusively to the hardness of metals and its measurement. In this respect it is a pioneer volume. One reads the book with the assurance that he is sitting at the feet of an authority in his subject. Anyone who has kept up with the literature of hardness measurement, will recall many papers bearing the name of O'Neill.

This new book by Dr. O'Neill is a distinct contribution to the subject of hardness and its measurement. It is not a book which the average man, running the routine hardness tests in a shop, will read as a guide to testing. Rather it is a compendium for the professional metallurgist.

The author has divided his book into nine well balanced chapters. One could wish that the Introductory Essay on Hardness in general might have been elaborated. It is excellent so far as it goes and is the sort of discussion needed to clarify our concepts of the property of hardness. However, Dr. O'Neill believes he should devote the most of his space "to a detailed consideration of the various methods which have gone to build up the hardness testing edifice." This he has done in a masterly fashion.

First the author spends considerable time on "Features of Some Static Indentation Tests." Chapters 1 and 2 comprise this general topic. Chapter 3 discusses the various instruments commonly used for static and dynamic indentations. This technical side of the subject is then followed by the theoretical and practical relations between hardness on the one hand and cold working, crystallinity and heat treatments on the other. Chapters 4, 5, 6 and 7 are the most valuable in the book from the standpoint of learning what constitutes hardness. Chapter 8 follows with a discussion of the preparation and examination of the specimen to be tested. The final chapter deals with properties closely allied with hardness, such as abrasion, wear, cutting hardness and machinability.

S. R. Williams (9b) —B—

Influence of Shape of Specimen, Manner of Gripping, Velocity of Test, and of the Testing Machine on the Upper and Lower Yield Point of Steel (Einfluss der Form des Probestabs, der Art der Einspannung, der Versuchsgeschwindigkeit und der Prüfmaschine auf die Lage der oberen und unteren Streckgrenze von Stahl). F. KOERBER & A. POMP. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 16, 1934, pages 179-188. Tests with round specimens of soft and medium-hard C steels showed a distinct influence of the type of testing machine on the upper yield point while very little influence was noticeable on the lower yield point. Square specimens did not reveal any influence on either point. The upper yield point increased, in general, with higher velocity of increase of load, the lower remained unchanged. If the samples had a rectangular section with a ratio of the sides of 1:4, the difference between the upper and lower yield point is small. Specimens with square sections show mostly higher values for both yield points and greater differences between them than flat specimens. The manner of gripping had no great influence on either upper or lower yield point. Results are given in detail. Ha (9b)

The Role of Diamonds in Hardness Testing (Der Diamant in der Härteprüfung). P. GRODZINSKI. *Technisches Zentralblatt für praktische Metallbearbeitung*, Vol. 44, 1934, pages 46-49. States that diamonds of different origins are not equally hard. The Rockwell Tester employs a diamonod cone (120°) whose tip is ball-shaped. Up to impressions of 30μ ball indentations are secured. Due to shocks, splinters easily split off, but careful handling proved that wear shows up only after several years of service. The Vickers hardness tester which utilizes a diamond pyramid (136°) calculates the hardness from the ratio load (5-50 kg.): area of impression in analogy with the Brinell machine. Both methods arrive at the same hardness values up to 360 kg./mm.^{2} The diamond tips of the scleroscope are made in such a manner as to yield rebound hardness of 90 with reference to a Rockwell C hardness of 60. The drilling hardness of Jaggar is determined by a drilling test with a diamond tetrahedron under 10 g. load. The number of revolutions required for a depth of 10μ is taken as a hardness measure. EF (9b)

On the Dependency of Pressure upon the Sharpness of Cutlery. SHOITI YAMAMOTO. *Kinzoku no Kenkyu*, Vol. 11, Sept. 1934, pages 422-427. Samples of cutlery having a straight edge and a definite edge-angle 21° were made of 0.9% C steel; after heating at 830° for 30 minutes they were cooled at 760° and kept for 10 minutes at the temperature, then only were they quenched in water of 10° C. for 1.5 seconds and then in boiling water to avoid the quenching cracks. After they were polished and sharpened by special whet stones, they were tested under different pressures by Honda's sharpness tester. KT (9b)

Test Bars for Cast Steel (Contribution au Projet de Normes sur l'Acier Moulé-Barreaux d'Épreuve en Acier Moulé). OTTON MARCINOWSKI. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, Aug. 1934, pages 364-368. Polish exchange paper presented at Nancy Foundry Congress, July 1934. Proposes a standard test specimen for cast steel. The specimen to be a plate cast on edge, gated on one end above the center line. The lower half to be tested. This gave best physical tests. WHS (9b)

Wear Testing of Cam Rolls. *Iron Age*, Vol. 133, June 14, 1934, pages 16-17. Outlines method of testing to yield fundamental data permitting more intelligent design of cam contour and production of cams having longer life. A reconditioned Olsen wear-testing machine was used. The 1" and 1½" diam. rolls used in test were of Cr-V tool steel. With static load of 1800 lb. the Hertz contact stress was of the order of 250,000 lb./in.^{2} After approximately 19 million cycles the specimen had worn down only 0.0008" in diam. Rolls showed a purple discoloration and most of polish was lost. The rolls were considered to have satisfactory endurance limit and by operating dry very little wear was met. VSP (9b)

Contribution to the Determination of the Elongation of Welded Samples (Beitrag zur Bestimmung der Dehnung an Schweissproben). F. RÖTSCHER & J. QUADFLIEG. *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1113-1119. The elongation at rupture commonly determined with tensile test specimens permits no reliable conception of the elongation conditions of welded joints. The investigations of the authors go to show that the elongation of bending tests is more suitable for this purpose. The occurrences with the bending tests are considered at length. It is proposed to determine the bending elongation on a gage length of 5 times the sheet thickness. In these tests various types of welding electrodes were used so that also conclusions could be drawn on the suitability of certain electrodes for a given base material. For judging welding performance it is sufficient, when base material and electrodes of known properties are applied, to restrict determination of elongation of the seam to a gage length equal to the thickness. GN (9b)

9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cöoperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Corrosion-Fatigue Properties of Duralumin with and without Protective Coatings. I. J. GERARD & H. SUTTON. *Journal Institute of Metals*, Vol. 56, 1935, (Advance Copy), appearing in *Monthly Journal, Institute of Metals*, Nov. 1934, pages 507-525. Rotating-beam (cantilever) fatigue tests on duralumin were made in air and in a salt spray using various forms of protection of the surface of the specimens. The composition of the duralumin was, Cu 4.2%, Mn 0.64%, Mg 0.64%, Fe 0.82%, Si 0.22%. The values of endurance limits obtained for various protective coatings are given in the tabular statement below. In a salt spray lanolin coating and cadmium plating gave little protection, but zinc plating was more effective. Spraying with aluminum was not as good as zinc plating for long endurance. Coatings of organic resins and enamels gave good protection, especially when the metal had been previously anodized. Details of the application of coatings are given in the paper.

Test in	Protective Surface Treatment	Supplementary Organic Protective	Endurance Limit Reversed Flexure lbs./in.² 10 Million Cycles	50 Million Cycles
Air	None	None	20,400	20,200
	Anodic	None	25,100	24,600
Salt Spray	Anodic	Synthetic resin varnish (stoved)	27,300	21,300
Salt Spray	Anodic	Pigmented oil varnish	21,300	18,600
Salt Spray	Anodic	Cellulose enamel	18,600	17,200
Salt Spray	Zinc-Plated	None	15,200	14,300
Salt Spray	None	Pigmented oil varnish	16,800	13,200
Salt Spray	None	Synthetic resin varnish	14,300	12,800
Salt Spray	Sprayed with Al.	None	14,100	10,800
Salt Spray	Anodic	Lanolin	10,800	10,100
Salt Spray	None	Cellulose enamel	9,900	9,600
Salt Spray	None	None	7,400	6,700
Salt Spray	None	Lanolin	6,900	5,800
Salt Spray	Cadmium Plated	None	7,800	5,600

HFM (9c)

Endurance of Key-way Assemblies and the Improvement due to Cold-working of the Key-way (Die Biegewechselfestigkeit einer Keilverbindung) (Passfederanordnung) und die Erhöhung der Dauerhaltbarkeit durch das Oberflächendrücken). H. KOCH. *Mitteilungen des Wöhler-Instituts*, No. 20, 1934, pages 1-60. Several previous reports from the Wöhler-Institut have dealt with the coldworking of the corners and edges of key-ways to improve their endurance properties, the tests having been made on rotating shafts with empty key-ways, without anything being fastened onto the shaft. Koch extends this work to the study of shafts with masses keyed on. Using a square-based key and key-way there is high local stress, and hence an intense notch-effect at the corner from the presence of the rotating mass which is keyed on. This reduced the endurance to 46% of the value in an ordinary, unnotched endurance test in a soft 0.08% C, 52,000 lbs./in.² tensile steel and to 33% in a 0.34% C, 84,000 tensile steel. The greater notch-tenderness of the harder steel made it but little more effective than the softer. Cold working of the key-way bottom, corners, and edges by special tools with an air-hammer improved the endurance 20% with both steels, this being a greater improvement than was found from cold working in previous tests by others on empty key-ways. HWG (9c)

A New Key-form with Improved Endurance of the Shaft (Eine neue Keilform mit besserer Dauerhaltbarkeit der Welle). O. FÖPPL. *Mitteilungen des Wöhler-Instituts*, No. 20, 1934, pages 63-67. Koch's results (see preceding abstract) emphasize the damaging effect of local stress exerted by the key in the key-way on a rotating shaft, and the locality of the failures indicates that this is worse toward the ends of the key. Föppl in 1929 suggested using two keys in the same key-way, one of copper which would deform and distribute the stress, the other of steel. Föppl now suggests making the key solid only at the middle, each end being slotted with the slots leading into recesses, so that the key is springy at each end. Various radii of curvature for the recesses have been studied and are illustrated. The best design of key studied showed about 6% improvement over a solid key. In terms of life at the stress which gives a life of 1 million with a solid key, one new form increased the life to 5 million cycles. HWG (9c)

The AMSLER Systems of Load Measurement in Universal Testing Machines of Hydraulic Construction

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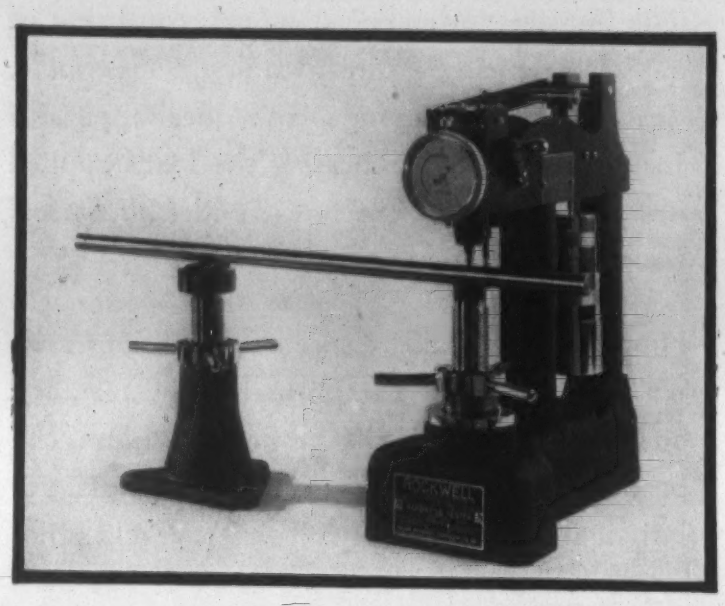

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Endurance Tests on Two Silico-Manganese Steels (Essais d'endurance sur deux aciers mangano-siliceux). G. PIQUET. *Aciers Speciaux, Métaux et Alliages*, Vol. 9, Apr. 1934, pages 107-114; May 1934, pages 137-144; June 1934, pages 162-175. Rotating cantilever machines have been used in testing two silica-manganese steels. According to author this kind of test embodies many conditions to which the metals are subjected in service. The composition of the 2 steels was:

	C	Mn	Si	Ni	Cr	S	P
Steel No. 1	0.42	1.83	0.76	—	—	0.019	0.05
Steel No. 2	0.4	1.63	0.57	0.60	0.70	0.019	0.05

The steels were tested as: annealed, water quenched, water quenched and drawn (4 temperatures), oil quenched, oil quenched and drawn (four temperatures). The dilatometric curves give 635° C. for Steel No. 2 and 700° C. for Steel No. 1 as the transformation points of samples which were made from 20 mm. diameter rounds and heated in muffle furnace, quenched in water at 15° C. and drawn in salt bath. The following tests have been performed: tensile tests, hardness, impact, micrographic examination and endurance test (rotating cantilever). A formula was developed in determining the endurance limit in relation to load applied and dimensions of test specimen. The effects of heat treatment on physical properties of the steels are given as follows:

STEEL NO. 1

Treatment	E.L. Kg./mm.²	T.S. Kg./mm.²	Elong. %	Red. of Area %	Brinell Hardness	End. Limit Kg./mm.²	End. Limit T.S.	End. Limit E.L.
Annealed	47	75	23	57	192	41.87	0.52	0.83
Water Quench 900° C.	—	178	0.4	0	559	41.34	0.22	...
Water Quench 900° C. Draw 400° C.	164	167	1.0	23	472	51.34	0.29	0.30
W.Q. 900° C. Draw 450° C.	147	153	3.0	29	418	51.94	0.32	0.33
W.Q. 900° C. Draw 500° C.	130	137	5.4	36	377	50.88	0.35	0.37
W.Q. 900° C. Draw 550° C.	114	124	7.7	40	316	....	...	...
W.Q. 900° C. Draw 600° C.	97	110	10.4	49	251	47.73	0.41	0.47
Oil Quench 900° C.	—	160	0.6	3	463	48.76	0.28	...
O.Q. Draw 400° C.	140	165	2	19	402	54.06	0.30	0.346
O.Q. Draw 450° C.	110	147	4.3	25	375	53.0	0.39	0.45
O.Q. Draw 500° C.	94	130	6.8	32	357	51.94	0.44	0.51
O.Q. Draw 550° C.	79	114	9.2	40	286	....	0.45	0.57
O.Q. Draw 600° C.	64	95	12	51	241	46.11	0.46	0.68

STEEL NO. 2

Treatment	E.L. Kg./mm.²	T.S. Kg./mm.²	Elong. %	Red. of Area %	Brinell Hardness	End. Limit Kg./mm.²	End. Limit T.S.	End. Limit E.L.
Annealed	56	74	22	56	187	41.87	0.52	0.71
Water Quench 900° C.	—	188	0.5	0	555	38.69	0.20	...
W.Q. 900° C. Draw 400° C.	175	182	2	14	470	53.53	0.28	0.246
W.Q. 900° C. Draw 450° C.	152	161	3.3	28	402	52.47	0.31	0.33
W.Q. 900° C. Draw 500° C.	127	140	5	32	356	51.41	0.35	0.39
W.Q. 900° C. Draw 550° C.	108	121	8.7	38	311	....	...	...
W.Q. 900° C. Draw 600° C.	85	103	13	47	267	48.23	0.45	0.535
Oil Quench 900° C.	—	176	1	7	463	48.76	0.28	...
O.Q. 900° C. Draw 400° C.	151	166	4	20	404	54.59	0.33	0.34
O.Q. 900° C. Draw 450° C.	133	150	5.5	27	373	50.88	0.39	0.376
O.Q. 900° C. Draw 500° C.	116	134	7.5	33	340	47.70	0.44	0.415
O.Q. 900° C. Draw 550° C.	101	120	11.5	42	255	....	...	...
O.Q. 900° C. Draw 600° C.	89	107	15.5	51	241	45.58	0.47	0.485

Microscopic examination showed that a sorbitic structure is that for which the endurance limit is the highest. Martensitic and pearlitic structures do not give such high endurance limit. 129 references. GTM (9c)

Fatigue of Steels (Recherche sur la Fatigue des Aciers). R. CAZAUD. *Usine*, Vol. 43, Sept. 13, 1934, pages 25-27. Investigations with various plain and alloy steels did not reveal a simple relation between stress limit and elastic limit because internal stresses and structure determine to a great extent the behavior. The ratio fatigue to elastic limit can be as low as 0.29 for very hard steel and as high as 1.32 for pure Fe and steel with 23% Ni. The method of testing by rotating bending is considered useful in classifying steel with respect to strength and fatigue and is recommended for selecting a steel of proper quality and heat-treatment. Drawing, especially at 600° C. after hardening, has a favorable effect, as it produces a homogeneous, osmonditic structure which is often preferable although elasticity and strength are somewhat reduced. Micrographic examination shows that fatigue cracks are always of an intercrystalline nature, both for ferrite and austenite. (Editor's Note: This is contradictory to a large mass of experimental evidence.) A table gives the ratio of fatigue to strength for steels of ferritic, pearlitic, austenitic, martensitic and osmonditic structure for different compositions and heat-treatments. Ha (9c)

Some Further Experiments on Atmospheric Action in Fatigue. H. J. Gough & D. G. Sopwith. *Journal Institute of Metals*, Vol. 56, 1935 (Advance Copy), appearing in *Monthly Journal, Institute of Metals*, Nov. 1934, pages 477-506. Previous experiments had shown that fatigue tests in partial vacuum gave for some metals distinctly higher endurance limits than fatigue tests in air. Three suggested explanations for this result are: (1) oxygen is the primary factor, with the presence of water as a catalytic agent also necessary, (2) that atmospheric impurities, acid and alkaline are responsible, and (3) that impurities, mainly gaseous, dissolved in the metal react with the metal during repeated stress. To examine (1) and (2) fatigue tests have been made on copper and brass in four environments: air, partial vacuum, dry purified air, and moist purified air. To examine possibility (3) fatigue tests in air and in partial vacuum have been made on copper containing cuprous oxide, on oxygen-free copper and on copper deoxidized with phosphorus. The results of the tests on copper and brass suggest strongly that acid and alkaline impurities in the air have little, if any, influence on atmospheric corrosion-fatigue, but that oxygen in the presence of moisture is probably primarily responsible. The results of the tests on oxide-bearing and on deoxidized copper show that the comparative behavior of these metals when tested in air and in partial vacuum is unaffected by the different compositions of the dissolved gases in the two materials. Fatigue tests in air and in partial vacuum are also reported for lead and for Armco iron. The following table summarizes results. The endurance limits were obtained under reversed direct stress (tension-compression).

Metal	Approx. Chem. Analysis	Condition as Tested	Tensile Strength lbs./in.²	Test Environment	Endurance Limit lbs./in.²
Armco Iron	0.02% Cu 0.03% Mn	Normalized	49,500	Atmosphere	29,000
				Partial vacuum	29,300
		Annealed	.....	Atmosphere	24,000
				Partial vacuum	24,400
Mild Steel	0.13% C	Hot-rolled	62,700	Atmosphere	29,100
				Partial vacuum	30,700
Medium Steel	0.5 % C	Cold-rolled	141,600	Atmosphere	48,700
				Partial vacuum	50,400
Non-corroding Steels	15.00% Cr 0.12% C	Hardened and Tempered	97,000	Atmosphere Partial vacuum	49,300 49,800
	17.00% Cr 1.2 % Ni 0.25% C	Hardened and Tempered	122,100	Atmosphere Partial vacuum	63,300 63,300
	18.00% Cr 8.00% Ni 0.1 % C	Cold-rolled	148,500	Atmosphere Partial vacuum	55,800 54,300
Nickel-Chromium Steel	3.4 % Ni 0.6 % Cr 0.36% C	Hardened and Tempered	201,600	Atmosphere Partial vacuum	79,600 81,800
Duralumin	4.25% Cu 0.64% Mg 0.82% Fe	Rolled	62,700	Atmosphere Partial vacuum	17,600 18,500
Magnesium Alloy	2.46% Al	Rolled	36,700	Atmosphere Partial vacuum	12,600 12,600
Copper	99.96% Cu 0.04% O_2	Annealed	32,200	Atmosphere Partial vacuum Dry pure air Damp pure air	9,900* 11,000* 10,800* 10,100*
Copper, Oxygen-free	99.96% Cu	Extruded	32,000	Atmosphere Partial vacuum	9,600* 10,300*
Copper, Deoxidized with Phosphorus	99.96% Cu 0.018% P	Extruded	33,400	Atmosphere Partial vacuum	9,900* 10,100*
Brass	78.92% Cu 30.11% Zn	Annealed	44,400	Atmosphere Partial vacuum Dry pure air Damp pure air	16,800 20,800 17,700 16,600
Cupro-Nickel	78.92% Cu 20.61% Ni	Annealed	50,400	Atmosphere Partial vacuum	18,100 18,100
Lead	99.99% Pb	Extruded	2,700**	Atmosphere Partial vacuum	380* 850*

* Endurance limit determined by tests to 30,000,000 cycles of stress.
** Speed of head of testing machine 0.2 in. per min.

HFM (9c)

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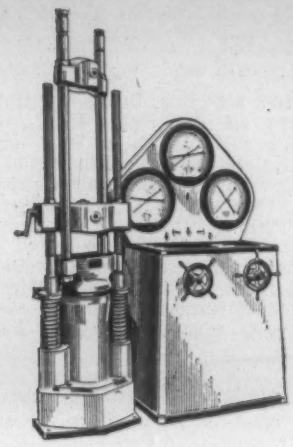

The wide use, in this country, of hydraulic testing machines has been a development of the past few years. There were, of course, a few outstanding precision testing machines having mutually independent load producing and load measuring hydraulic systems, such as those designed and built by A. H. Emery for the Watertown Arsenal and the National Bureau of Standards; but their cost limited their use to laboratories in which price was a secondary consideration.

Therefore, when a testing machine in which load was indicated by an hydraulically-actuated pointer before a graduated dial was made commercially available to materials engineers, there were doubts as to its reliability and accuracy.

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9d. Magnetic Testing

L. REID, SECTION EDITOR

Effect of Direction of Spontaneous Magnetization upon Resistance (Der Einfluss der Richtung der spontanen Magnetisierung auf den Widerstand). S. STEINBERG & F. D. MIROSCHNITSCHENKO. *Physikalische Zeitschrift der Sowjet Union*, Vol. 5, 1934. No. 2, pages 241-252. Experimenters determined how direction changes of the spontaneous magnetization affect the electrical resistance of Ni, Fe, 15/85 Ni-Fe and 36/64 Fe-Ni, whereby the direction of the specific magnetization was ascertained by elastic deformation, i.e. by (1) stretching and (2) torsion. EF (9d)

1

Magnetic Properties of Steel and Iron During Stretching (Magnetische Eigenschaften von Stahl und Eisen bei Dehnung). E. LOPUCHIN. *Physikalische Zeitschrift der Sowjetunion*, Vol. 5, No. 1, 1934, pages 57-74. There is no auto-magnetization of Fe and steel under the influence of pure elongation without the effect of an external magnetic field. The magnetic determination of the limit of elasticity according to Fraichet does not yield sufficiently reproducible results and is unsuitable for commercial purposes. A new method of determining the elastic limit with the aid of the magnetic curve gained during the stretching of test bars in the earth's magnetic field is introduced. An accuracy of the testing method of 3% holds for soft Fe and steel (.3%C). With high C and alloy steels the method fails due to hysteresis phenomena although the accuracy drops to only 15% as compared with a mean error of 200% in Fraichet's testing method. EF (9d)

2

Magnetic Properties of Natural and Artificial Iron-Oxygen Compounds. I. Magnetic Measurements on Powdered Specimens (Ueber die magnetischen Eigenschaften natürlicher und künstlicher Eisen-Sauerstoff-Verbindungen. I. Ueber magnetische Messungen an pulverförmigen Proben). W. LUYKEN & L. KRAEBER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 15, 1934, pages 169-178. A method for measuring paramagnetic and ferromagnetic substances in form of powder was developed and the application for the determination of the magnetic properties of Fe-O compounds is described. Magnetization curves of different materials are given. Ha (9d)

Preparation of Samples and the Results of Epstein Tests (Ueber den Einfluss der Probeherrichtung auf die Messergebnisse an Epsteinproben). F. WEVER & HEINRICH LANGE. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 13, 1934, pages 155-158. Attention is called to the fact that when testing Fe sheets magnetically in the Epstein apparatus, errors in the results can be caused by the manner of stacking and pressing the single strips together. To avoid this it is suggested that a definite rule for bundling the strips be adopted. Ha (9d)

9e. Spectrography

Spectro-Analytical Investigations of Commercial and Pure Metals. III. Aluminum (Spektralanalytische Untersuchungen technischer und reinster Metalle. III. Aluminum). WALTER GERLACH & ELSE RIEDL. *Sitzungsberichte der mathematisch-naturwissenschaftlichen Klasse der Bayrischen Akademie der Wissenschaften*, 1933, No. II, pages 227-236. The effect of small amounts of impurities on the physical properties of Al and the difficulties of preparing Al in a highly pure state are pointed out. The chemical determination of impurities also offers great difficulties. The chemical determination of Ga and Sc (present in considerable quantities) is apparently not carried out and the authors disclaim any knowledge of the determination of Ni and Ag which can also be identified spectroscopically. The significance of spectro-analytical quantitative analysis is discussed and its accuracy compared with chemical analyses worked out for traces. The spectroscopic bands gained on some 15 German, American and Italian brands (commercial and "chemically pure") of Al are presented showing lines of the following elements: Cu, Fe, Ga, Mn, Si, V, Ti, Cr, Ni, Pb, Ag, Zn, Sc, and Sn. The intensities of the spectral lines show the ratio of the atomic percentages of the contaminations but not weight percentages. Mg, alkalines and earth alkalines are not listed. Spectro-analytical methods are not far enough advanced. Ca was present in almost all samples investigated. Sr. and Sc respectively were found in particular in two American brands. A further investigation was undertaken to determine whether or not the impurities accumulate at the grain boundaries during solidification or recrystallization. The experimental results were negative. EF (9e)

6

Spectroscopic Investigation of Purest Metals (Spektralanalytische Untersuchung reinster Metalle). W. GERLACH. *Die Naturwissenschaften*, Vol. 22, May 25, 1934, page 336; *Sitzungsberichte der Bayrischen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse*, 1933, No. II, pages 15-16. Pb could be detected spectroscopically in Zn of the highest purity. Zn of the purity class IV (contaminations in the range of some thousandths of a %) contains Pb, Cd, Ag, Cu, Fe and occasionally Cr and Ni. Fe is distributed very unevenly in cast Zn plates. It is probable that the corrosion starts at the regions where Fe accumulated during solidification. EF (9e)

8

The Absence of Fine Structure in the Arc Spectrum of Silver. S. TOLANSKY. *Proceedings Physical Society*, Vol. 45, July 1933, pages 559-564. Includes discussion. Examination of the arc spectrum of silver with a variable-gap silvered Fabry-Perot interferometer has revealed no trace of fine structure. It is concluded that this is due to the electron configuration and not necessarily to smallness of the nuclear magnetic moment. JCC (9e)

9

Spectrographic Control Applied to Ore Concentration. (Om spektralanalytisk driftskontroll, särskilt med tilllämpning för malmanrikning). STURE MÖRTSELL. *Jernkontorets Annaler*, Vol. 118, Apr. 1934, pages 204-212. A general discussion of methods is given. For analysis of Cu cencentrates, a small sample is rapidly dried and spread evenly over an asbestos plate. The plate is rotated through a heater which vaporizes the Cn, and a spectroscope is used to select the wavelength 3247$\mu\mu$. By measuring the intensity of this light by a photoelectric cell and galvanometer, the amount of Cu present may be estimated. HCD (9e)

Bohemium (Bohemium). MAX SPETER. *Die Umschau in Wissenschaft & Technik*, Vol. 38, Sept. 9, 1934, page 739. Spectroscopic investigation of Noddack on the newly discovered element 93 designated Bohemium by its discoverer Koblic did not indicate the presence of a new element, but a mixture of V, W and other metals. WH (9e)

10

Preparation of Spectroscopically Pure Carbon Electrodes (Über die Herstellung von spectralreinen Kohlenelectroden). A. K. RUSSANOW. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 219, Sept. 29, 1934, pages 332-334. The copious lines of the carbon spectrum make it difficult and sometimes impossible to determine even the elements that are not contained in the electrode. Electrodes not given special treatment have spectrum with lines chiefly of Fe, Si, Al, Ti, V, Ca, Mg and B. Electrodes used for analytical work are heated to 2500°-3000° C. for purification. Investigation was made of temperature and time necessary to remove impurities. 5 mm. diameter electrodes were heated electrically between water cooled iron holders from 10 seconds to 3 minutes, for less than 2 minutes above 2250° C. no protection from air is needed. For 3 minutes of heating the results showed 2250° C. no purification, 2480° C. weak lines of Ca, Mg, B, Cu remained, 2640°-2900° C. barely visible lines of Ca, Mg, B remained. 15 seconds at 2690° C. and 25 seconds at 2720° removes completely the main impurities Fe, Si, Ti, Al, V, and only weak lines of Ca, Mg, Cu, B remain. 30 seconds at 2700° C. is enough to remove the Cu also and after one minute at 2650° C. only scarcely visible lines of Ca, Mg, B remain. WB (9e)

Experiments on the Limits of Spectroscopic Detection of Cadmium and Palladium in Silver (Versuche über die Grenzen der spektroskopischen Nachweisbarkeit von Cadmium und Palladium in Silber). G. BAIERSDORF. *Wiener Anzeiger*, 1934, No. 5, page 54. The lowest contents of Cd and Pd which could be detected spectroscopically in Ag were found to depend materially on the method of excitation. For Cd the limit with reference to sparks was less than 10^{-4}% and 10^{-6}% in the arc. Down to 10^{-3}% Pd could be discovered in the arc. Two electro-chemical concentration methods were tried on Pd. EF (9e)

3

Constitution of Dysprosium, Holmium, Erbium, Thulium, Ytterbium, and Lutecium. F. W. ASTON. *Nature*, Vol. 133, Mar. 3, 1934, page 327. Preliminary results of analysis of these rare earth elements on the Moss spectrograph. CSB (9e)

A "Synthetic Spectrum" Method of Analysis and its Application to the Quantitative Estimation of Small Quantities of Bismuth in Copper. D. M. SMITH. *Journal Institute Metals*, Vol. 55, Advance Copy No. 682, Sept. 1934, 9 pages. The method provides for the production of spectra as standards for comparison, the spectrum of a standard alloy being exactly superimposed on that of the pure metal that forms the major constituent. The total time of exposure is equal to the normal time of exposure of a sample that is being analyzed and a series of spectra is obtained in which impurity lines show a systematic increase in intensity. Once the calibration is made the method can be used for quantitative determination of impurities in metals. The application to the determination of 0.0001 to 0.004% Bi in Cu is described. JLG (9e)

4

The Spectrographic Detection and Estimation of Minute Quantities of Impurities in Copper. M. MILBOURN. *Journal Institute Metals*, Vol. 55, Advance Copy No. 680, Sept. 1934, 6 pages. A method for spectrographic analysis of Cu samples weighing less than 0.5 grams is described. An arc is passed between a rod of pure Cu, made the positive electrode, and 0.2 to 0.5 grams of the sample supported in a shallow cup in the end of the graphite rod. The method is accurate for the detection of small quantities of Bi, As, Pb, Fe, Ni, Sb, and Sn. As tends to boil off, and should be determined from a spectrograph taken immediately after the arc is struck. Relative intensities of impurity and Cu lines useful in analyses are given. Cu containing P tends to volatilize rapidly in the arc. 6 references. JLG (9e)

5

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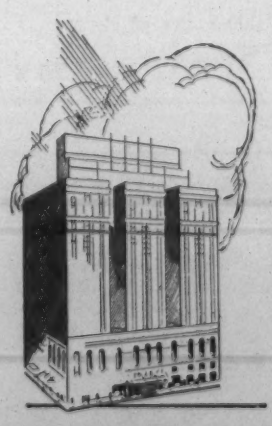

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10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Problem of the Nature of Twin Interfaces (Zur Frage nach der Natur der Zwillingsbildungsflächen. Vorläufige Mitteilung). E. G. Ananiaschwili & D. B. Gogoberidse. *Physikalische Zeitschrift der Sowjetunion* Vol. 6, No. 1/2, 1934, pages 184-185. Debye pictures disclosed a finely crystalline layer between adjacent twin crystals contradicting previous assumptions of an amorphous intermediary layer or of a direct contact of twins. EF (10)

Handbook of Metal-physics. Vol. 1, Part 1. The Metallic State. (Handbuch der Metallphysik. Band 1, Teil 1. Der metallische Zustand der Materie). Edited by G. Masing. **Lattice Structure of Metallic Systems (Gitteraufbau metallische Systeme),** pages 1-180. U. Dehlinger. **Principles of the Metallic State—Physical Properties of Metals (Grundlagen des metallischen Zustandes—Physikalische Eigenschaften der Metalle),** pages 181-485. G. Borelius. Akademische Verlagsgesellschaft, Leipzig, 1935. Cloth, 6¾ x 9¾ inches, 520 pages. Price 47.60 RM.

Masing's Handbook is to include four sections, this book being the first part of the first section, to be followed by one on mechanical and chemical properties. The second volume will deal with mechanical and thermal treatment, the third with iron, steel and ferro alloys and hard metals, the fourth with heterogeneous equilibria.

Since the advent of X-ray methods for the study of the lattice structure some 20 years ago, physicists have found metals interesting and metallurgists have found that X-ray methods throw new light on the problems of why metals act as they do. Hence, a new science has been built up, more specialized than general physics, but more distinctly a subdivision of physics than what used to be included in the term "physical metallurgy" when that was viewed as a branch of physical chemistry. Masing terms this new science "Metal-physics."

This, on the whole, is still a rather "high-brow" subject, its detailed development being followed chiefly by university professors, and among these the professors of metallurgy are outnumbered by the professors of physics. Yet the most promising avenue to a practical result may often be pointed out by the consideration of compatibilities and incompatibilities in lattice structure. The literature of the subject, phrased in terms difficult for the novice to grasp, is scattered through thousands of publications, many of them expensive foreign journals. The summarizing of this material into hand-book form is a convenience and a service ably carried out by Dehlinger. The tabulation of the structures of a vast number of intermetallic compounds makes this section of the book especially useful for reference. The new facts brought out by X-ray study as well as the evidence corroborative to the methods of the older physical metallurgy are presented, and X-ray methods sufficiently discussed.

In the second section of the book, Borelius discusses physical (not mechanical) properties of metals and alloys such as electron configuration, compressibility, expansion, density, liquid viscosity, specific heat, magnetic, electrical, thermal, thermoelectrical, etc., etc. The relation of electron configuration to all of these is discussed. The theory of magnetism is given particular attention.

In both sections of the book rare elements get as much attention as common ones, the task being to show how every metallic element in the periodic system behaves and how all these behaviors may be tied together by fundamental theory.

The cream is skimmed from several thousand references cited. In many cases the facts are boiled down into curves. The book is authoritative, will become one of the prime reference sources, and whets our appetite for the later volumes of the series. H. W. Gillett (10) —B—

Transformation of the α-Phase of Copper-tin Alloys due to Cold Working. (Die Umwandlung in der alpha-Phase der Kupfer-Zinn-Legierungen infolge Deformation. Vorläufige Mitteilung). S. Konobejewski & W. Tarrassowa. *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, No. 3, 1933, pages 571-575. Contrary to previous determinations by Heycock & Neville, Bauer & Hansen, Westgren & Phragmén (X-rays) the solubility of Sn in Cu was not found to remain constant (8.5 at. % Sn) with falling temperatures. The following maximum solubilities were established by X-rays:

Temperature, °C.	300	340	385
Solubility, at. % Sn	4	6.4	7.1

The powder samples from the homogenized α-phase were directly annealed at low temperatures. Due to the stresses induced by cold working during the preparation of the powder, a lattice constant was found different from that of powders first recrystallized at a higher temperature. In some powder samples 2 lattice constants were found, suggesting a 2-stepped transformation as in Cu-Ag alloys, according to Ageew, Hansen & Sachs. Attention is called to the considerably increased precipitation speed of $CuAl_2$ in a Cu (2%)-Al alloy due to cold working. A greater mobility and diffusion speed in Cu-Sn alloys submitted to cold working is responsible for the approach to "true thermodynamic equilibrium conditions" in the otherwise frozen-in alloy. The existence of further alloys with "suppressed transformations" and the possibility of improving their physical properties by suitable mechanical and thermal treatment is pointed out. EF (10)

Theory of Linear Crystallisation Velocity (Zur Theorie der linearen Kristallisationsgeschwindigkeit). R. Kaischew & I. N. Stranski. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 170, Oct. 1934, pages 295-299. Previously presented derivation of the formation speed of crystal nuclei is extended to the case of linear crystallisation speed. Theoretical calculations are compared with experimental evidence. Usefulness of applying this theoretical treatment to recrystallisation phenomena is indicated. EF (10)

Ternary Diagram of Al-Cu-Si System. Kanji Matsuyama. *Kinzoku no Kenkyu,* Vol. 11, Oct. 1934, pages 461 to 490. (In Japanese). Al-Cu, Cu-Si, and Al-Si diagrams were precisely redetermined by means of thermal analysis, electric-resistance measurement and microscopic examination. The system Al-Cu-Si was then investigated from melt to room temperature. There are 18 monovariant curves and 8 nonvariant points. The α-, β-, γ- and δ-solid solutions of systems Cu-Al and Cu-Si were found to be contiguous. In solid state there are 9 monovariant curves and 2 nonvariant points. KT (10)

Quaternary Intermetallic Compounds. A. S. Russell. *Nature,* Vol. 133, Feb. 10, 1934, page 217. If metals of one class (Zn, Sn, Cd, Hg) react in Hg with a metal of another class (Cu, Fe, Co, Ni, Mn), many binary, ternary, and quaternary compounds may be formed. $Sn_4Cu_{12}Zn_4Hg_2$, $Sn_5Cu_{15}Zn_5Hg_9$, $SnCu_3ZnHg_8$, $SnCu_3ZnHg_9$, $Sn_4Cu_{12}Zn_4Hg_{45}$, $Sn_4Cu_{12}Zn_7Hg_{21}$, $Sn_4Cu_{12}Zn_7Hg_{33}$, are approx. formulas for compounds formed from $SnCu_3Hg$. Other compounds are also listed. Hume-Rotherys' valency electron rules for compounds are confirmed and extended; total number of valency electrons appears more significant than electron to atom ratio. CSB (10)

Compression Tests on Highly Dispersed Metal Powders at Elevated Temperatures. III (Über Warmpressversuche an hochdispersen Metallpulvern. III). W. Trzebiatowski. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 169, June 1934, pages 91-102. An apparatus was constructed suited for preparing sintered metallic bodies in a reducing atmosphere and at elevated temperatures. (20°-600°C.). Under pressures of 15,000 atm., Cu and Au have been experimented with and density, hardness, electric resistance tests and microstructural examinations were made. Hardness and density increase up to 200°C. The X-ray picture showed the characteristics of strain hardening. Due to the latter the remarkable hardness of 190 and 162 kg./mm.² respectively for Cu and Au were secured. Due to crystal recovery (X-rays) hardness drops between 200° and 400°C., while density increases. No crystal growth, however, occurs. The densities of solid metals are attained while the hardness remained at a remarkably high level. Specific electric resistance and temperature coefficient of the sintered metals correspond to normal values. At 450°-600°C. a further hardness drop takes place due to recrystallization. (See also *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 414 L9). EF (10)

Precision Measurements of Rhombohedral Crystals: $NaNO_3$ (Mesures de précision des réseaux rhobeoédriques: $NaNO_3$). Note on Precision Measurements of Hexagonal Crystals: Zn. (Note sur la mesure de précision des réseaux hexagonaux: Zn) pages 51-56. Introduces a graphical-extrapolation method suitable for precision determination of parameter values of non-cubic crystals. The application of the evaluation method is demonstrated with reference to $NaNO_3$ and Zn. Regarding Zn, a was found to be 2.6585_0 A.U. and $a_3 = 4.9341_5$ A.U. EF (10)

Universal Significance of the Face-centered-cubic Structure with Respect to the Fundamental Interpretation of Relationship Hitherto Unknown (Über die universelle Bedeutung der kubisch-flächenzentrierten Gitterstruktur für die ursächliche Erfassung von bisher unbekannten Zusammenhängen). Richard Reinicke. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Oct. 1934, pages 28-36. In contradistinction to present conceptions that the mass distribution of highest symmetry represents the characteristic feature of a crystal, the NaCl structure and some other structural types are interpreted as charged lattices (Ladungsgitter). The face-centered-cubic arrangement merely appears as a special case of the latter. Based on the fact that the noble gases and many of the metals crystallize in the face-centered-cubic system, it is concluded that by splitting off its valency electrons, a metal decomposes into that noble gas which is its closest neighbor in the periodic system. The lattice of a univalent metal is considered to be built up by positive metal "particles" Me (cations) and free electrons el, in other words by a stable molecule Me-el which is analogous to the NaCl molecule. The electrons naturally escape identification by X-rays. The problem of electric conductivity, supra-conductivity, electro-magnetic induction, photo-electric phenomenon and the problem of mass are discussed in the light of the new hypothesis. EF (10)

Structure of the Beryllium Carbide Be_2C (Die Struktur des Berylliumcarbids Be_2C). M. v. Stackelsberg & F. Quatram. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Oct. 1934, pages 50-52. X-ray powder photographs showed that Be_2C has an anti-fluorite lattice with a = 4.33 A.U. Density = 2.44. Distance Be—C = 1.87 A.U. and distance between 2 carbon atoms = 3.06 A.U. The atomic radii ratio of Be_2C is compared with that of Mg_2Si which also crystallizes in the anti-CaF_2 structure. EF (10)

Precipitation Hardening with Particular Consideration of Casting Alloys (Die Ausscheidungshärtung, unter besonderer Berücksichtigung der Gusslegierungen). E. Söhnchen. *Die Giesserei,* Vol. 21, July 20, 1934, page 311. In precipitation hardening, 3 stages are distinguished: 1) Wandering of the hardening atoms through the crystal lattice of the solid solution with simultaneous deformation of the lattice; 2) Commencement of precipitation with formation of an intermediary lattice; 3) Final precipitation of the precipitation component with formation of the stable lattice. The observation of these stages by their thermodynamic effects is explained. By adding a 3rd element to a binary system the solubility line can be shifted to the right or left; in both cases, the hardening effect is reduced. The influence of grain size on hardening effect and hardening velocity is discussed; both increase with increasing fineness of grain. Some practical examples are given to show proper selection and amount of hardening agent and calculation of heats of mixture. Ha (10)

The Influence of Nonmetallic Inclusions upon the Precipitation of Primary Cementite in Hypereutectoid Steels. E. G. Mahin & E. F. Lee. *American Society for Metals Preprint* No. 9, 1934, 13 pages. Precipitation of cementite in hypereutectoid steels produced by prolonged cementation of commercially pure iron was studied. It was assumed that segregation in such material would be practically nil. It was observed that the cementite network tends to follow the inclusions; a great majority of the inclusions though not all, are included in the network. The divorce of pearlite in "abnormal" steels is due to coalescence of a distinct phase rather than diffusion by osmotic pressure. It is suggested that abnormality increases the difference between the surface tensions of cementite and ferrite, which results in the coalescence of the phase of higher surface tension into masses of lower relative surface. 12 references. WLC (10)

Manganese-silicon Alloy of the Tungsten Type. A-2 Type (Über eine Mangan-Silizium Legierung vom Wolfram Typ. A-2 Typ). FRITZ LAVES. *Zeitschrift für Kristallographie*, Vol. 87, Oct. 1934, pages 189-191. Independent investigations on the Mn-Si system yielded the following intermetallic compounds: (See *Metals & Alloys*, Vol. 5, July 1934, page MA 349 R 7)

Borén	Vogel & Bedarff
Mn_3Si	Mn_3Si
MnSi	Mn_5Si_3
	MnSi

Laves investigated the alloy of Vogel and Bedarff corresponding to Mn_5Si_3 and found this phase to be identical with Mn_3Si of Borén. However the Mn_3Si alloy of Vogel and Bedarff was found to possess a body-centered-cubic structure with $a = 2.85 \pm 0.01$ A. U. and 2 atoms per unit cell, i.e. the A-2 type (W type) with statistic distribution of the Mn and Si atoms. Single crystals did not show a super-structure. Mn_3Si cannot be considered as an intermetallic compound but as a substitution solid solution of a body-centered-cubic Mn modification which does not exist in the pure state. In the same manner as meta-stable modifications become stable by temperature changes, concentration variations are able to bring about the same effect. The higher the Si content in Fe-Si solid solutions the more the homogeneity range of the face-centered-cubic γ-Fe modification becomes restricted so that above 5 at. % Si only the body-centered cubic Fe modification remains stable. EF (10)

Absorption Factor in Electron Diffraction (Der Absorptionsfaktor bei der Elektronenbeugung). W. E. LASCHKAREW & A. S. TSCHABAN. *Physikalische Zeitschrift der Sowjetunion*, Vol. 6, No. 3, 1934, pages 205-210. Intensity measurements with rapid electrons diffracted on artificially oxidized Mg showed that the absorption factor of electrons is identical with that of X-rays. EF (10)

The Effect of Surface Stress on Solid Solubility. ARTHUR PHILLIPS & R. M. BRICK. *Metals & Alloys*, Vol. 5, Sept. 1934, pages 204-205. Amorphous metal hypothesis is discussed. Micrographic evidence suggests polishing produces a surface of some of the characteristics of crystal boundary regions. Surface material is analogous to boundary precipitation accompanying intergranular corrosion phenomena. WLC (10)

Investigations of Pure α-, β- and γ-Manganese (Untersuchungen an reinem Alpha- Beta- und Gammamangan). F. BRUNKE. *Annalen der Physik*, Series 5, Vol. 21, Oct. 1934, pages 139-168. The methods of producing the α-, β- and γ-phases of pure Mn are described: α-Mn is obtained by evaporation in vacuum, β-Mn by quenching of Mn melts from 1100° C. and γ-Mn by electrolysis of aqueous solutions of Mn chloride. Magnetic, electric and thermal behavior, and X-ray structure were determined. 34 references. Ha (10)

Crystal Absorption by Subtrates. G. I. FINCH, A. G. QUARREL & J. S. ROEBUCK. *Nature*, Vol. 133, Jan. 6, 1934, page 28. Zinc vapor condensed on polished copper yields an electron diffraction pattern which rapidly fades away, yet when it is deposited on sputtered or etched copper, its pattern does not fade. Authors interpret this as evidence for Beilby amorphous layer on polished metal. CSB (10)

Contributions to the Systematic Doctrines of Affinity 61. Construction and Use of a High Temperature Calorimeter with closed Reaction Chamber. (Beiträge zur systematischen Verwandtschaftslehre 61. Bau und Verwendung eines Hochtemperaturkalorimeters mit geschlossenem Reactionsraum). WILHELM BILTZ, GERHARD ROHLFFS & HANS ULRICH v. VOGEL. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 220, Oct. 27, 1934, pages 113-141. Calorimeter developed for heats of solution and thus heats of formation for various compounds; diagram, description and use of calorimeter given. Heats of formation of Au compounds determined in k.cal. at 90 C., $AuSn = 8.2$, $AuSn_2 = 5.5$, $AuSb_2 = 3.5$, $AuZn_3 = 22.5$, $AuZn = 11$, $Au_3Zn = 24$. These values together with others are used in a table to show that the heat of formation of the compound is higher when the second metal combined with the common metal is less noble than the first. One example of this is:

Compounds	Q (kcal.)	Volts
AuZn	11	—0.76
AuSn	8.2	—0.1

W B (10)

Structure of Real Crystals (Zur Struktur der Realkristalle). E. OROWAN & F. ZWICKY. *Helvetia Physica Acta*, Vol. 7, Apr. 25, 1934, pages 285-293, 294-297. Polemic on the secondary structure hypothesis advanced by Zwicky. The latter upholds his theory of coöperative phenomena which "furnishes (1) a quantitatively complete interpretation of the melting problem (correct coefficients of Lindemann and Trouton rules) and (2) a satisfactory explanation of the phenomena of strain hardening due to cold working." EF (10)

Segregations in the Ternary System Copper-iron-sulphur and Its Significance as a Geological Thermometer (Über Entschmischungen im System Kupfer-Eisen-Schwefel und ihre Bedeutung als geologisches Thermometer). HERMANN BORCHERT. *Chemie der Erde*, Vol. 9, No. 2, 1934, pages 145-172. Criticizing the unsatisfactory results of metallurgical investigations on synthetic Cu matte, about 2/3 of the ternary diagram Cu-Fe-S was established. The samples were heat treated at various temperatures and then studied microscopically. Graphical presentations show the segregations and stability ranges of the various Cu and Fe sulphides, for which special attention was paid to the effect of oxidation. The experimental results are applied to geological problems. WH (10)

Change of Mechanical Properties of Copper-rich Alloys due to the Grain Refinement by Peritectic Reaction. JUN ASATO. *Kinzoku no Kenkyu*, Vol. 11, Aug. 1934, pages 365-376. In Japanese. It was already reported by the author that the refinement of structure of Cu-Fe alloys is closely related to the peritectic reaction between copper and iron. Mechanical properties of 3 Cu-Fe alloys—sand-cast, metal-moldcast and heat treated—and 2 ternary alloys were studied. Every alloy showed the same tendency of change of properties; e.g., the tensile strength increases first very slightly, then more rapidly, and in the last, abruptly. The first case corresponds to the dissolving of iron in copper to form α-solid solution. The second is the period of precipitation of a solid solution, which mainly consists of iron and which is in a colloidal state. The last corresponds to the refinement of the structure by the peritectic reaction. KT (10)

Constitution of Hafnium and Other Elements. F. W. ASTON. *Nature*, Vol. 133, May 5, 1934, page 684. Report of mass spectrograph analysis of hafnium, thorium, rhodium, calcium, titanium, zirconium, samarium. CSB (10)

11. PROPERTIES OF METALS AND ALLOYS

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

A Study of the Physical Properties of some Low Tin, Iron-tin Alloys. G. M. COVER. Thesis for M. S. in Met. Eng. Case School of Applied Science, Cleveland, O. 1934. 48 typed pages—16 figures. Available at the Library, Case School. Vacuum melts of Armco iron plus added Sn were made up to contain 1 to 5% Sn in 1% steps. The 1% Sn alloy cracked on forging, those of higher Sn content flew to pieces. Another series was prepared with 0.1, 0.2 and 0.3% Sn to indicate the behavior of residual Sn in steel, but in alloys of only 0.01 to 0.02% C. The ingots were allowed to freeze in the crucible in which they were melted, were reheated to 1000° C. and forged. They cracked on forging but the cracks healed on further forging. Radiographic examination showed no cracks in the finished forging nor did any develop on testing. The forged bars were normalized from 1000° C., which gave a coarse grain size. Tensile and impact tests were made, which confirmed previous observations on the embrittling effect of small amounts of Sn. Even 0.1% Sn cut the elongation from 38 to 8%, the reduction of area from 71 to 4% and the Charpy impact value fell to a fraction of a food pound. Increase of Sn to 0.2 and 0.3% slightly increased the brittleness. Rockwell B hardness fell from 49 to 46 with 0.1% Sn but then rose to 51 for 0.2% and 56 for 0.3%. Qualitative observations during forging indicated that the hot-hardness was increased also. Quenching from 700, 800 and 950° C. and aging at 100° C. showed no indication of precipitation hardening. The Sn appeared to be, and stay, in solution in ferrite. A case of alpha veining was met in an alloy with 4.22% Sn. It is usually considered that the alpha-gamma inversion must occur to produce alpha veining. If so, the gamma loop must extend, at some temperature to at least 4.22% Sn, though the equilibrium diagrams of the Fe Sn system usually show the gamma loop to extend only to about 2% Sn. HWG (11a)

On the Dispersion Theory in Metallic Conductors II. YOSHIO FUJIOKA. *Scientific Papers Institute of Physical & Chemical Research, Tokyo*, Vol. 22, Nov. 1933, pages 202-215. In English. Deals with the effect of a damping factor upon the formulae for conductivity and dielectric constants. The results of the calculation show that if the damping factor is considered to be large the effect on the conductivity is fairly appreciable, while the dielectric constant is hardly affected. The theoretical derivations are checked by experiments on Ag. WH (11a)

Tests on Tin-base and Lead-base Bearing Metals. C. JAKEMAN & G. BARR. *Technical Publication, International Tin Research and Development Council*, Series A., No. 6, July, 1934. 23 pages. Account of work done at National Physical Laboratory, England. A steel backed bearing 2" diam., 2¼" long with a ¼" lining of white metal was run against a 2" diam. NiCr steel shaft (composition, hardness and other properties not stated) in a bearing testing machine equipped for heating the oil and for measuring the coefficient of friction. Babbitts of around 4% Sb. 3 to 4% Cu, ¼ to ½% Pb, balance Sn, of 21½ Brinell; one of 82 Sn 11 Sb 3 Pb 4 Cu, of 22½ Brinell; lead alloys of 80 Pb 15 Sb 5 Sn, of 21 Brinell; and an alkali lead alloy containing about 0.6% Na 0.7% Ca 0.05% Li, balance Pb, of 35½ Brinell, were studied. Tests were run at 1000 lbs./in.² projected area, 1300 r.p.m. for 100 hours at a range of temperatures, using castor, olive and sperm oils, as well as mineral oils such as Mobile A. Acidity as oleic varied from 0.06% in a mineral oil to 1.4% in sperm. The bearings started with 8 mils clearance. Rates of wear are given for the 82% Sn and 80% Pb alloys for various oils. The results are not very conclusive as wear was relatively large in the wearing in period, and bearings that had been worn in with one lubricant wore very little in a subsequent test with another, even one with high acidity, but on the whole the Pb bearing wore appreciably more. The Pb bearing also showed a slightly greater coefficient of friction at 40° or 70° C. Sludge was formed in the oils of high acidity. Olive oil of 1.1% gave 5 times as much sludge when used in the Pb bearings as in the Sn bearings. The mineral oils were not notably altered in either bearing. The alkali-hardened Pb alloy was run in olive oil, but after 92 hrs. the clearance had increased from 8 mils to over 39 mils on one diameter of the bearing and large amounts of sludge were formed by the chemical attack of the oil on the alloy. The bearing also failed by cracking. Another bearing of the alkali lead alloy was compared with the 82% Sn alloy in Mobile A by running at increasing loads. The two behaved about alike up to 1020 lbs./in.² but at 1530 lbs./in² the lead alloy failed by cracking, while the Sn alloy withstood 2550 lbs./in.² Two other alkali lead and 82% Sn bearings were run at 1300 r.p.m. and 900 lbs./in.² and the temperatures raised till each seized. The Sn seized at about 170° C., its coefficient of friction remaining quite constant from 70° to 170°. The Pb alloy, having shown a trace lower coefficient at starting, had an increasing coefficient from 70° to 200°, doubling in this range and thereafter rising still more rapidly till it flowed out of place at about 230°. The alkali hardened lead appears to be limited to low loads and temperatures and to lubricants low in acidity. The 80% Pb alloy is not readily attacked by normal lubricants, while the 82% Sn alloy is the most resistant to attack of acid-containing lubricants. The authors conclude that the high Sn alloys on the whole give lower friction than the high Pb alloys. In some of the tests, however, the differences are so small that this generalization should not be too strongly phrased. HWG (11a)

The Absorption Power of Palladium-Boron Alloys for Hydrogen (Das Absorptionsvermögen der Palladium-Bor Legierungen für Wasserstoff). ADOLF SIEVERTS & KURT BRÜNING. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 168, June 1934, pages 411-418. Hardness, micro-structure and absorption ability for H between 20° and 900° C. are determined on 4 alloys of Pd containing up to 16.6 at. % B max. The H pressures were 6 atm. at 215° C. and 1 atm. at higher temperatures. The hardness of the annealed (700° C.) alloys increases as follows due to rising B contents:

Weight % B	0	.26	.75	1.60	1.98
Brinell hardness	45	195	245	275	285

A homogeneous solid solution was found with the Pd-B alloy of .75% B while 2 constituents are present in the 1.6 and 1.98% B alloy. The H absorption power drops in all alloys with rising temperatures. At constant temperature the absorbed quantity is proportional to the square root of the pressure. This holds for alloys of .75 and .26% B only up to 500° C. The isotherms of the latter alloy takes a course similar to the curves obtained on the Pd-H system. The behavior of the Pd-B alloys is quite similar to that of the Pd-Au alloys. EF (11a)

Absorption Power of Solid Cobalt for Hydrogen and Nitrogen (Das Absorptionsvermögen des festen Kobalts für Wasserstoff und Stickstoff). A. SIEVERTS & H. HAGEN. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 169, July 1934, pages 237-240. Pursuing previous research on the solubility of gases in metals and alloys, the absorption ability of pure Co (trace of Fe and O_2) for H_2 was determined at atmospheric pressure between 600° and 1200° C. At varying pressures the quantity absorbed was equal to the square root of the H_2 pressure. The absorption power of technical Co, which contains about 2.5% Fe was hardly different from that of the pure metal. N_2 is practically insoluble in Co up to 1200° C. The different absorption power of Fe, Co, and Ni is ascribed to their different crystal structure. Face-centered cubic Ni and γ-Fe possess the largest absorption power for H_2 and the hexagonal Co the lowest. Since there is a face-centered cubic modification of Co, it is predicted that the latter will have a larger absorption power for H_2 than the ordinary form of Co. EF (11a)

Alloys of Copper and Nickel (Les Alliages de cuivre et de Nickel). LÉON GUILLET. *Cuivre et Laiton*, Vol. 7, June 30, 1934, pages 271-272. Brief review of properties. The thermal diagram of these alloys is very simple, the liquidus is a single branch of the curve extending from the melting point of Cu to that of Ni in almost a straight line; the solidus is similar and little distant from the liquidus. Ni is magnetic at ordinary temperatures and has a transformation point at 375° C. Alloys with less than 63% Ni are non-magnetic. Cupro-nickels are white when Ni is higher than 20%. The expansion coefficient changes fairly regularly from 17.22×10^{-6} (Cu) to 14.04×10^{-6} (Ni). Temperature has an influence on mechanical properties but less so than on steel, pure Ni is superior to steel with regard to permanent deformation under pressure. Technical applications are described. Ha (11a)

Alloy Steels To-day. D. HANSON. *Metallurgia*, Vol. 10, July 1934, pages 75-78. Discussion of influence of alloying elements. JLG (11a)

Revision of the Atomic Weight of Niobium; Analysis of Niobium Pentachloride (Revision des Atomgewichts des Niobs; Analyse des Niobpentachlorides). O. HOENIGSCHMID & K. WINTERSBERGER. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 219, Aug. 14, 1934, pages 161-167. Methods of determination and of preparation of pure Nb are described. The revised atomic weight of Nb is 92.91. Ha (11a)

New Cadmium-silver-copper Bearing Alloys Developed by Federal-Mogul. A. F. DENHAM. *Automotive Industries*, Vol. 71, Nov. 24, 1934, pages 640-642. This new type of high load capacity bearing material, which has already entered large scale automotive production, is said to have a lower manufacturing cost, less likelihood of scoring soft shafts, greater resistance to corrosion and to require less running clearance than is the case with leaded bronze bearings. Compared to tin base metals, the cadmium base alloy has higher physical properties at all operating temperatures and a higher factor of safety due to its melting point of 135° F. above that of babbitt. Less than 1% Cu is added to increase strength and stiffness. Ag in solid solution increases ductility and improves fluidity and castability by making the molten alloy less susceptible to oxidation. The alloy tends to soften at 200-250° F., a desirable effect for conforming the bearing to the shaft, but regains its hardness after prolonged operation at higher temperatures. Photomicrographs and illustrations are included. BWG (11a)

Special Properties and Applications of Beryllium-Copper Alloys. EDWIN F. CONE. *Iron Age*, Vol. 132, Sept. 7, 1933, pages 18-19, 66. Outlines properties resulting from heat treatment and cold working of some Be-Cu alloys and their applications. In cast condition the Be-Cu alloys have high resistance to wear. Electrical conductivity of these alloys is high as compared to steel, P bronze and other high strength materials. Hardness of a 2% Be-Cu alloy is increased by rolling. Machinability is one of its outstanding properties. VSP (11a)

Aluminum Alloys (Aluminiumlegierungen). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Oct. 28, 1934, pages 457-459. Proposed new standard sheet D I N E1713 for Al alloys describing composition, properties and application of: (A) malleable alloys (1) alloys containing Cu and low Mg content—Dural type (2) alloys containing Cu, Mg, Ni—Y type, (3) Cu bearing alloys—Lautal type, (4) Mn bearing alloys—Mangal type, (5) Cu free alloys with low Mg content—Anti-corodal type, (6) alloys with Mg and Sb content—KS seawater type, (7) alloys with high Mg content—Magnalium type, (8) alloys with Si content—Silumin type, (B) casting alloys (1) alloys with Si content (a) eutectic Si-Al alloys—Silumin type, (b) hypo-eutectic Si-Al alloys—Pantal type, (2) alloys with Mg content (a) above 4%—Magnalium casting type, (b) Mg below 4%—seawater casting type. GN (11a)

Special Alloys (Speziallegierungen). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 5, 1934, page 330; Aug. 18, 1934, page 352; Sept. 2, 1934, page 372; Oct. 28, 1934, page 456. Discusses composition, properties and application of (1) Ermann metal, a ternary alloy of low melting point (93°C.) with 50% Bi, 25% Sn, 25% Pb, (2) Eutectic, ternary or quaternary alloys of Bi, Pb, Cd and Sn, (3) Everbrite an English corrosion and heat resisting Cu alloy, (4) Excelsior electric resistance alloy of 54.4% Cu, 45.2% Ni, .3% Fe, (5) Ex-B metals, Pb bearing bronze containing 77% Cu, 8% Sn and 15% Pb, (6) Excello electric resistance alloy containing 85% Cu, 14% Cr, .5% Fe, .5% Mn. (7) F alloy an American die casting alloy of 75.5% Al, 20% Zn, 2.5% Cu, .5% Mg, .75% Si and .5% Mn and .2% Fe, (8) Fahr metals, heat resisting Fe-Cr and Fe-Ni-Cr alloys, (9) Fahrenwald white gold containing 60-90% Au, 10-40% Pd, distinguished by high acid resistivity, (10) Fahrig antifriction metal of 90% Sn, 10% Cu, (11) Fermet heat and acid resisting Fe-Ni-Cr alloy with 74% Fe, 18% Ni, 4% Cr, 2.2% Mn, 1% W, .4% C and .3% Cu. GN (11a)

1 **The Effect of Impurities on the Surface Tension of Type Metal Alloys.** H. V. WHITE. *Engineering Experiment Station Bulletin* No. 17, Virginia Polytechnic Institute, Vol. 27, June 1934, 51 pages. The head of molten type metal required to force the metal into a groove a millimeter deep and about 0.2 millimeters wide, to represent the detail in fine type, was determined, using a special apparatus which is fully described. From this, the surface tension was computed. Both oxidizing and reducing atmospheres were used. Oxidation increases the surface tension, but not very much, save in the presence of some impurities. The pressure-width constant, i.e., the pressure required to force the metal into a groove of given width, at 10°C. above the melting point, was, for Pb 105; for Sn, chemically pure, 110; for monotype metal of 16.5% Sb, 7% Sn, balance Pb, 95. Addition of impurities to the monotype metal raised the surface tension slightly, to from 96 to 99, in experiments with 0.15 and 0.30% As, 1 and 4% Bi, 1% Cd, 0.10% Mg, 0.08% Fe, or 0.05% K. The only impurities that had marked effect were 0.20% Zn, which increased the p-w constant to 122, or 29%, and 0.05% Na, which decreased it to 67 or 30%. Surface tension figures are also given. Sodium acted very differently from potassium. Sodium-treated metal appears very fluid, and that containing 0.08% Fe appears very viscous, yet neither one notably affects the actual casting properties. Interesting discussion of many factors in casting type metal is included. HWG (11a)

2 **Type Metals.** H. VANCE WHITE. *Metal Progress*, Vol. 24, Dec. 1934, pages 17-21, 56. Describes the development of various type metals and their properties, particularly their ability to reproduce fine detail. This property is not due, as generally supposed, to an expansion on solidification but to some other cause as yet uncertain. WLC (11a)

3 **History, Properties and World Production of Aluminum (Geschichte, Eigenschaften und Welterzeugung des Aluminiums).** H. RUDERER. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 84-85. Production in the most important countries and price movements are given. 8 types of Al alloys are distinguished: 1. refinable Al alloys, 95.5% Al, 0.5-3% Cu, 0.5% Mg, 0.5-0.8% Mn (duralumin); good construction material, not for casting. 2. Cu-Al, up to 8% Cu as alloy for fabrication beyond for casting. 3. Ternary Cu-Zn-Al alloys with 8-10% Zn and up to 5% Cu as fabricating and casting alloys. 4. Ternary alloys with up to 5% Zn and 8% Cu as fabricating alloys. 5. Ternary Ni-Al alloys with 1.5-10% Ni for sheets, bars, tubes and thick-walled vessels which are particularly exposed to oxidation but not subject to mechanical stresses. 6. Al-Mg alloys with 1.5% Mg. 7. Mg-Al alloys of the elektron type. 8. The casting alloys of the silumin type with 11-14% Si. Ha (11a)

4 **Thermodynamic Functions of Aluminum, α - Aluminum Oxide, β - Graphite, Oxygen and Carbon Monoxide (Die thermodynamischen Funktionen von Aluminium, α - Aluminiumoxyd, β - Graphit, Sauerstoff und Kohlenmonoxyd).** L. TEREBESI. *Helvetia Chimica Acta*, Vol. 17, July 2, 1934, pages 804-819. Data on specific heats, heat content, entropies, and free energies of Al, Al_2O_3, $C_{graphite}$, O_2 and CO are supplemented by new experiments and all data tabulated. EF (11a)

5 **Nüral Piston Alloys (Nüral Kolbenlegierungen).** OSKAR SUMMA. *Deutsche Motorzeitschrift*, Vol. 11, Oct. 1934, pages 194-200. Al piston alloys are classified as (1) Cu and (2) Si bearing alloys. The former contain up to 20% Cu and low amounts of Mg, Zn, Ni, while the latter (Nüral 132) contain up to 25% Si besides other elements. Group (2) is characterized by a low thermal expansion coefficient and specific weight. Microstructures of Si bearing piston alloys are shown referring to different heat treatments and Si contents. Ni was found to raise the strength at elevated temperatures whereas excess Cu contents increase the tendency towards segregation and shrinkage. Experimental data on thermal expansion of plain and heat-treated Al-Si alloys are given. Irregular growth of cast Al-Si is counteracted by thermal treatment and proper alloying. Ultimate strength, yield point and elongation of Nüral between 10° and 400°C. are graphically shown and its hardness between 20° and 300°C. is compared with elektron and cast Fe. The hardness-temperature curve of Nüral lies between those of competing piston materials. Annealing Nüral at 160°C. for 300 hrs. did not reduce its hardness. WH (11a)

6 **The Mechanical Properties of Copper-Zinc Alloys (Sur les Propriétés Mécaniques des Alliages Cuivre-Zinc).** W. BRONIEWSKI & S. TRZEBSKI. *Revue de Fonderie Moderne*, Vol. 28, June 25, 1934, pages 173-178. A historical review of the development of industrial Cu-Zn alloys since 1880; new investigations are described of the mechanical properties of not-oxidized Cu-Zn alloys up to 44% Zn and of the influence of an oxidizing atmosphere during melting; hardness and resilience of alloys annealed at 550° and of alloys cold worked 40% have been measured. The curves of hardness, tensile strength and elastic limit are horizontal between 20 and 36% Zn with increases on either side; elongation shows a minimum and a maximum at about 13 and 32% Zn; reduction of area drops sharply at 40% Zn, after having been constant from 22 to 40%. Cold-working influences mainly reduction of area under tensile stress which is reduced considerably and almost independent of composition; hardness, tensile strength and elastic limit are increased but retain the general behavior of the annealed alloys. Oxidation during melting influences particularly the brasses with 12-35% Zn, elongation, reduction of area and resilience are reduced while hardness and tensile strength are increased. A table gives figures for tensile strength, elastic limit, elongation at fracture, uniform elongation, hardness and resilience for compositions from 0-44.1% Zn in small steps. 12 references. Ha (11a)

7 **Heat Treated Aluminum Alloys (Les Alliages d'Aluminium de Fonderie a Traitement Thermique).** PIERRE BARRAND. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, Aug. 1934, pages 369-373. Paper presented at Nancy Foundry Congress, July 1934. An Al alloy with 4.5% Cu and 0.4% Ti, when heat treated gave average tensile strength of 45,600 lbs./in.² with an elongation of 4 to 7%. Mg added to this alloy increased the strength slightly. Al alloy with 4% Si, 1% Mg, and 1% Mn, when heat treated gave tensile strength of about 40,000 lbs./in.² with elongation of 1.5% and was resistant to corrosion and took a high polish. For strength Al was alloyed with Cu, Ni, Mg, Mn, Si, Ti, Co, etc. For corrosion resistance, Sb or Cd were alloyed with Al. Great care in regulating temperature and avoiding deformation or strain was necessary in the heat treatment of Al alloys. WHS (11a)

Properties and Uses of Hydronalium (Eigenschaften und Verwendung von Hydronalium). R. SPITALER. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 162-165. Hydronalium alloys are Al alloys with up to 15% Mg and small additions of Si, Mn, Zn, which are manufactured in such manner that the intercrystalline corrosion formerly often encountered is eliminated by producing a definitely saturated solid solution. Strength and yield point increase with increasing Mg content. Joints of hydronalium with other metals, especially heavy metals should be insulated in order to avoid local electrochemical corrosion; the insulation can be obtained by hot galvanizing of the heavy metal at the joint, or by varnishing, or interposing lacquered cloth or linen strips. The material has been used with good success in marine structures and small boats, on account of its excellent resistance to sea water. Ha (11a)

Development and Present Status of Elektron Metal (Entwicklung und heutiger Stand des Elektronmetalles). P. SPITALER. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 113-121. Elektron alloys contain 90% and more of Mg and variable amounts of Al, Zn, Mn or Si. The first 3 form a limited range of solid solutions with Mg, and the solubility at the eutectic temperature is in each case considerably greater than at room temperature. This permits precipitation hardening and thermal refining. Metallographic constituents are described and the mechanical properties of the different types of elektron alloys are compiled in tables and the field of application stated. Saving in weight of machinery parts against other materials is illustrated by examples. 6 references. Ha (11a)

Diffusion in Au-Pb and Ag-Pb Alloys. Third Communication on the Diffusion of Metals in Solid Lead (Diffusion in Au-Pb und Ag-Pb Legierungen. Dritte Mitteilung über Diffusion von Metallen im festen Blei). W. SEITH & A. KEIL. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 22, Sept. 1933, pages 350-358. The mechanism of the diffusion of Au and Ag in Pb is investigated by determining the self-diffusion of Pb which contains 0.03 at. % Au or 0.08 at. % Ag. The relatively great mobility of both noble metals in Pb as compared with the slow self-diffusion of Pb in Pb is linked to the relatively small lattice loosening-up heat ("Auflöckerungsarbeit") or unbinding energy ("Ablösungsarbeit") of Au (14 000 cal./mol.) and Ag (15 200 cal./mol.) as compared with 28 000 cal./mol. for Pb. The mobility of foreign atoms in the Pb lattice is greater than that of the Pb atoms themselves and increases in the following order: Sn, Tl, Bi, Cd, Ag, Au. The experimenters hold that Pb forms a solid solution with Au and Ag at low concentrations of the latter metals. The constitutional diagram Pb-Ag is established up to 0.6 atomic % Ag by conductivity measurements according to Grube. It shows the existence of a homogeneous solid solution range up to about 0.15 at. % Ag. Samples which were cold worked by milling and then submitted to short heating times yielded diffusion values 10 times larger than on annealed specimens. Low additions of Au and Ag strongly reduce the recrystallization ability of Pb resulting in the largest diffusion values in case of short heating times. The recrystallization temperature of pure Pb is shifted from room temperature to higher temperatures due to the addition of Au. The atom mobility is temporarily increased by the recrystallization process. In long time tests, the slow diffusion rate predominates in the annealed metal. The self-diffusion velocity is larger in cold worked Pb than in recrystallized Pb. (See also *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 276 R8). EF (11a)

Physico-Chemical Peculiarities of Light Metals (Physikalisch-chemische Besonderheiten der Leichtmetalle). ROBERT MÜLLER. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 121-126. Properties of light metals including such metals as Ti, Zr, Ta, La, are discussed. As the most characteristic properties are considered 1. the dense, tough, but thin oxide film formed in air spontaneously, 2. the extraordinary electrochemical behavior, and 3. certain "non-metallic" properties of the light metals. At ordinary temperature, the oxide film has a thickness of only about 0.0002 mm. and protects the metal from further attack by air; it becomes much thicker at higher temperatures and visible. All light metals are electrochemically passive, they can be activated temporarily by removing the oxide film and then behave like base metals. Very small amounts of Hg suffice to activate them. The action of Hg on Al, Mg and Be is described more fully. Ha (11a)

Supraconductivity of Films of Tin. E. F. BURTON. *Nature*, Vol. 133, Mar. 24, 1934, page 459. Thin films of tin cease to show supraconductivity for either high frequency current or direct current, when these films are themselves plated over with a film of non-supraconducting metal such as Cu or Ni. CSB (11a)

Properties of Sublimed Calcium (Propriétés du Calcium Sublimé). PAUL BASTIEN. *Comptes Rendus*, Vol. 199, Sept. 10, 1934, pages 577-579. Calcium of 99.3% purity was sublimed by the Chaudron-Hérenguel process and remelted under an atmosphere of argon. Coeff. dilation (Chevenard) in argon atmosphere:

From 20° to 100° C. $= 25.2 \times 10^{-6}$
Hardness (Pomey & Voulet apparatus) $\Delta = 13$
Density (hydrostatic method) d 20° $= 1.542 \pm 0.0005$
Modulus of Elasticity (Martens) 2000
Modulus of Elasticity (Le Rolland & Sorin pendulum) 2600. FHC (11a)

Brass Alloy That Can Be Die-Cast. JOHN R. FREEMAN, JR. *Machinery*, N. Y., Vol. 41, Dec. 1934, pages 211-212. Brass of 60% Cu and 40% Zn is the most suitable for die-casting as it has the lowest melting point of the commercial brasses so that the available steels for dies will stand up under operation. Injurious oxidation is retarded by addition of 0.1-0.2% of Al. The most widely used composition in American and European practice consists of 60% Cu, 1% Sn, 1% Pb, about 0.1% Al, remainder Zn.; minimum tensile strength is 55,000 lbs./in.², elongation 9% in 2 in. Melting point is about 900° C. Such die-castings are very dense, no leakage occurred under 800 lbs./in.². pressure. Ha (11a)

Tests on White Metals for Socketing Winding-Ropes. JOHN WILSON. *Transactions Institution of Mining Engineers*, Vol. 85, Aug. 1933, pages 292-297; Vol. 86, Nov. 1933, pages 81-83; Jan. 1934, pages 189-191; Vol. 88, Oct. 1934, page 6. See *Metals & Alloys*, Vol. 5, July 1934, page MA 368. AHE (11a)

11b. Ferrous

E. S. DAVENPORT, SECTION EDITOR

1 **German Malleable Iron as Material in the Construction of Machines and Apparatus (Deutscher Temperguss als Werkstoff im Maschinen-und Apparatebau).** K. ROESCH. *Die Giesserei*, Vol. 21, June 22, 1934, pages 264-271. Developments and improvements in recent years in Germany are reviewed. Malleable Fe is used mainly for small sections; it has the good pouring and casting qualities of gray Fe and in addition has, after malleablization, almost the strength of steel. The diagram of Maurer shows the composition of various types of malleable Fe; white malleable Fe has 3-3.2% C and 0.5-0.7% Si, black (American) malleable Fe 2.6-2.9% C and 0.9-1.1% Si. White castings are malleablized in an oxidizing environment whereby C is partly oxidized; this gives a white fracture. Black castings are malleablized in a neutral packing whereby the cementite is decomposed to ferrite and graphite, causing a black fracture. White Fe is produced almost exclusively in cupola furnaces; this has the advantage of liquid material always being available. Black malleable Fe is preferably melted in a reverberatory furnace fired with powdered coal; this furnace, however, has the disadvantage of high fuel consumption, above 25-30% of the charge, and liquid material is not continually available. The Brackelsberg rotary type of furnace is qualitatively the best furnace for both types of malleable Fe; fuel consumption is about 18-20%; C can be kept below 3% and S below 0.06%. Data on properties are presented in photomicrographs and curves. During the last 5 years, 65,000 tons have been produced in 70 foundries at an average cost of 0.64 Mk./kg. About 10% was black malleable Fe. Ha (11b)

2 **Corrosion Resistant Structural Steel and New Rustless, Casting Steels (Ueber witterungsbeständigen, schwerrostenden Baustahl und neuartige rostfreie und vergiessbare Stahlsorten).** GEO. KURSCHER. *Oberflächentechnik*, Vol. 11, July 17, 1934, pages 153-155. General discussion. Detailed properties are given of heat and corrosion resistant chromium-base alloys, but the compositions of the alloys are not stated, only trade names such as "Spiegelguss," "Pyrodur" and "HSB" being given. Ha (11b)

3 **Effect of Nitrogen on High Chromium Steels (Action de l'azote sur les aciers à haute teneur en chrome).** M. BALSKY. *Aciers Spéciaux, Métaux et Alliages*, Vol. 9, July 1934, pages 207-212. A review of published work of R. Franks on chromium steels improved by nitrogen. See "Chromium Steels Improved by Nitrogen," *Metals & Alloys*, Vol. 5, June 1934, page MA 286. GTM (11b)

4 **Interrelation Between Frequency and Permeability of Iron, Nickel and Cobalt (Frequenzabhängigkeit der Permeabilität von Eisen, Nickel und Cobalt).** R. SÄNGER. *Helvetia Physica Acta*, Vol. 7, July 14, 1934, pages 478-480. Paper before the Schweizerische Physikalische Gesellschaft, May 26, 1934. Shows the loss of ferro-magnetic properties (permeability) in the wave length range of 300-30 cm. The experimental values are compared with measurements on Fe and Ni by previous investigators. 9 references. EF (11b)

5 **Temperature Dependence of the True Specific Heat of Nickel (Ueber die Temperaturabhängigkeit der wahren spezifischen Wärme des Nickels).** E. AHRENS. *Annalen der Physik*, Series 5, Vol. 21, Oct. 1934, pages 169-181. The specific heat between 20° and 460° C. was redetermined and the anomaly near the magnetic transformation point more accurately investigated. Relation between resistance and spec. heat is discussed. Ha (11b)

6 **Why the Elastic Modulus of Iron is not a Constant.** J. M. LESSELLS. *Product Engineering*, Vol. 5, Dec. 1934, pages 453-454. Attention is called to the fact that the modulus of elasticity of cast Fe varies with the load and that this should be taken into account in designing. Determination of the variation with load is described. Ha (11b)

7 **Role of Manganese in Steels (Über die Rolle des Mangans in Stählen).** E. LACHMEIER. *Die Metallbörse*, Vol. 24, Sept. 29, 1934, pages 1242-1243; Oct. 6, 1934, page 1275. Discusses Mn equilibrium in steel making, occurrence of austenite, martensite and pearlite in relation to Mn and C content, and constitution of Fe-Mn system according to investigations of Levin & Tammann, Rümuelin & Fick, Dejean, and Gaylor. EF (11b)

8 **Catalytic Activity and Ferro-Magnetism (Katalytische Aktivität und Ferro-magnetismus).** J. ARVID HEDVALL & E. GUSTAVSON. *Svensk Kemisk Tidskrift*, Vol. 46, Mar. 1934, pages 64-65. In German. The authors discovered previously that the reactivity of solid materials increases during a phase transformation. This phenomenon has been discovered recently in instances in which no fundamental space lattice change takes place; for example the increase in reaction and dissolution speed of Cu and Bi at 70° and 75° C. respectively due to changes of secondary structure. The experimenters found, by studying the catalytic action of pure Ni and commercial Ni, that with changes of ferro-magnetism involving no changes in lattice symmetry, corresponding changes in the chemical and catalytic behavior occur. EF (11b)

9 **Effect of Copper on Gray Iron (Ueber den Einfluss von Kupfer auf Grauguss).** E. SÖHNCHEN & E. PIWOWARSKY. *Die Giesserei*, Vol. 21, Oct. 26, 1934, pages 449-453. Additions of Cu of about 0.5-2.0% to gray Fe improve strength, wear resistance and constancy of volume, while sensitivity to wall-thickness and size and amount of graphite are not influenced. The maximum amount of Cu soluble in gray Fe is 0.5-1.0%; the excess is precipitated in globular form. Coercive force, remanence and expansion coefficient are increased, thermal and electrical conductivity decreased up to 1% Cu, then increased again. Resistance to corrosion was found to be improved only in the case of acetic acid. 17 references. Ha (11b)

10 **Young's Modulus of Steel.** *The Railway Engineer*, Vol. 55, Oct. 1934, page 305. Highly accurate measurements of Young's modulus of elasticity showed that the latter is not independent of the heat treatment. Tests at the Research Department, Woolwich, and at the National Physical Laboratory indicated that pure Fe in the annealed condition has a modulus of elasticity of about 30.2×10^6 lbs./in.² and that with an increase of the C content this value diminishes to approximately 29.7×10^6 lbs./in.² In medium and high C steels the value of the modulus is approximately constant and heat treatment does not appear to affect the value. WH (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Thermal Autostabilization Method and its Use in the Study of Some Heat Resisting Steels (La méthode d'autostabilisation et son utilisation à l'étude de quelques aciers résistant à chaud). G. RANQUE & P. HENRY. *Revue de Métallurgie,* Vol. 31, June 1934, pages 248-265. Very detailed description of an apparatus for measuring creep at constant temperatures is given. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 538. JDG (12)

Impact Resistance of Cast Iron at Elevated Temperatures. F. B. DAHLE. *Foundry Trade Journal,* Vol. 50, Mar. 15, 1934, pages 179, 188. See *Metals & Alloys,* Vol. 5, Jan. 1934, pages 17-18. OWE (12)

The "Plasticity" of Iron at Low Temperatures. K. HEINDLHOFER. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 581, *Metals Technology,* Oct. 1934, 7 pages. Plasticity is commonly estimated from 3 types of tests—tensile, torsion, and impact. In ordinary low-C irons or steels impact resistance drops to a very low value as the temperature is lowered to about —30°C, elongation in the tensile test falls to a very low value in the neighborhood of —150°C, while ductility as indicated by torsion maintains a high value to a temperature at least as low as that of liquid H. It is concluded that these phenomena indicate that as the temperature falls below ordinary temperature the true cohesive strength of the material increases more slowly than does its shear strength. It is also suggested that a mechanical test of different materials, or even of the same material at different temperatures, does not necessarily yield comparable deductions as to the inherent properties of the material. JLG (12)

Use of Metals in the Construction of Furnaces (L'emploi des métaux dans la construction des fours). M. BASSAL. *Revue de Métallurgie,* Vol. 31, July 1934, pages 299-323. An extended survey covering the use of metals both for the outside shells of furnaces, and for parts in direct contact with the heat. Increased temperature lowers the mechanical properties of the metals and introduces physico-chemical changes sometimes of an undesirable nature. Metals can be strengthened at higher temperature by adjusting their chemical composition, by proper heat treatment (applicable only to the use at temperatures lower than those of final treatment), by precipitation hardening, by cold working and by case hardening. Common cast irons have quite poor heat resistance but are used widely on account of cheapness and ease of casting. Low-alloy cast irons have a greater strength at moderately high temperatures and have the advantage of greatly reduced warping. Austenitic cast irons precipitate their graphite in a finely divided state causing greatly reduced warping and are suitable for use up to 1000°C. Ni-Cr and Ni-Cr-Fe alloys alone or with different alloying elements offer a wide range of properties. Coating with a layer of a metal forming a heat resistant oxide is widely utilized in calorizing and to some extent in cementation with Zr. At slightly elevated temperatures, cast iron can be used for a resistance heating unit but for higher temperatures special alloys are to be preferred. JDG (12)

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Creep Strength of Steel Above 500° C. (Zur Frage der Dauerstandsfestigkeit des Stahls oberhalb 500° C.). A. POMP & H. HERZOG. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf,* Vol. 16, No. 12, 1934, pages 141-153. A steel is considered to possess practical creep strength if its speed of elongation does not exceed, in the 5th to 10th hr., 0.003% per hr. Experience has shown that this amount corresponds to 0.005% in the 3rd to 6th hr., and to 0.0015% in the 25th to 35th hr. An accelerated test based on these facts is described by which 2 C steels, 5 low alloy steels and 2 high alloy steels were tested at 550° and 600° C. in a Pb bath, and up to 800° in a hot air furnace. While up to 650° a limit of flow could still be observed under a load of 3 kg./mm.², the flow did not stop at higher loads. At higher temperatures, flow did not stop at all, even at low loads the steel showed a continuous, though slow flow. Tests are given in full. 15 references. Ha (12)

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X-ray Line Broadness of Metals and Alloys and its Relation to High Temperature Stability. J. E. WILSON & L. THOMASSEN. *Transactions American Society for Metal,* Vol. 22, Sept. 1934, pages 769-809. Recovery of X-ray line sharpness in cold-worked metals and alloys is studied as a function of time and temperature of annealing. Recovery of line sharpness is caused by diffusion of displaced atoms to their normal positions. In the case of Ni at low annealing temperatures the process involves a long induction period. Time-temperature relation for line sharpening was determined for Ni, Cu, and alpha brass. Mechanism of recovery based on hardness, electrical conductivity and other data is described. Immunity from "season cracking" in brasses can be predicted from line sharpening temperatures. Creep data on brasses, Cu-Ni alloys and pearlitic Mn and Mn-Mo steels are correlated with line broadness data. In a continuous series of solid solutions the alloy of maximum line-sharpening temperature has optimum creep characteristics. 27 references. WLC (12)

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Diffusion of Positive Ions of Salts Through Copper, Silver and Gold at Elevated Temperatures. Analysis of Emitted Ions by Means of a Mass Spectrograph (Diffusion des ions positifs des sels à travers le cuivre, l'argent et l'or à haute température. Analyse des ions émis à l'aide d'un spectrographe de masse). JEAN CICHOCKI. *Annales de physique,* Vol. 20, Dec. 1933, pages 278-317. In order to study the diffusion of salts through metals at elevated temperatures the salt under test was embedded in the metal, electrically heated, and the diffusing positive ions accelerated by an electric field. It was shown that, in addition to the metal ions of the salt, the ions of the surrounding metal and of the auxiliary electrode, new ions occurred, for instance, in the case of NaCl in Cu: Na, Na_2, CuNa, $CuNa_2$, Cu_2Na, Cu_2Na_2, PtNa. EF (12)

5

THERMALLOY
SERVES
ALL INDUSTRIES

Alloy Pan used in Chemical Industry

TYPICAL EXAMPLES

Enameling.....Racks, Bucks, etc.
Paint.....Lithopone Tubes
Chemical & Met.....Valves, Fittings, Tanks, etc.
Steel.....Rolling Mill Guides, Dampers, Skid Rails
Cement.....Chutes
Heat Treating.....Lead, Salt, Cyanide Pots, Carburizing Boxes, Retorts & Furnace Castings

Thermalloy
X-RAYED CASTINGS FOR HEAT CORROSION ABRASION

THE ELECTRO ALLOYS COMPANY
ELYRIA, OHIO

"Quality" Castings Since 1919

High Temperature Resistant Cast Irons (Les Fontes résistant aux Températures élevées). A. DAWANS & L. DENOEL. *Revue Universelle des Mines*, Vol. 10, Nov. 1, 1934, pages 572-585. Causes of growth and corrosion at elevated temperatures were investigated. Corrosion resistance at high temperatures is obtained by addition of Al, Si or Cr; for the same temperature the necessary percentage of these elements increases in the order named and is in amount proportional to the atomic weight. Ti and Mg also conform fairly well to this rule. The tests are fully described. 86 references. Ha (12)

Resistance Alloy for Temperatures Up to 1300° C. (Weerstandslegeering voor temperaturen tot 1300°). *Polytechnisch Weekblad*, Vol. 28, May 3, 1934, page 287. The most commonly utilized Cr-Ni alloys (65 Ni, 15 Cr, 20 Fe or 80 Ni, 20 Cr) are only suited for service temperatures of around 1000° C. Si-carbides must be used for higher temperatures thus necessitating electric resistances since the resistance does not change lineally with temperature. An alloy designated as Megapyr contains 30% Cr, 65% Fe and 5% Al and is claimed by Grunert, Hessenbruch & Ruf to be useful up to 1300° C. High specific electrical resistance and low temperature coefficient are valuable assets of this alloy. WH (12)

Chromium Irons Combat Heat, Corrosion. *Machine Design*, Vol. 6, Nov. 1934, page 36, page 68. High Cr-irons are finding heat resisting service where (alloy) gray Fe will not withstand the service conditions and the more highly alloyed Ni-Cr compositions are too expensive. 7 typical physical properties of 5 Cr-Fe alloys with 24-34% Cr and .85-2% Si (complete analyses given) are tabulated. The experiences of G. P. Phillips on the casting, corrosion, scaling and abrasion resistant properties are summarized. Excellent service in contact with Pb and Al and a higher corrosion resistance with the lower C grades are reported. The Brinell hardness of the alloys discussed varies between 228 and 363. Alloys responsive to heat treatment (quenching from 1900° F. in oil or air) may be hardened to 600 Brinell. Irons containing over 30% Cr are practically unaffected by heat treatment. WH (12)

Thermal Expansion of Some Alkali Halogenides and Metals at High Temperatures (Die thermische ausdehnung einiger Alkalihalogenide und Metalle bei hohen temperaturen). A. EUCKEN & W. DANNÖHL. *Zeitschrift für Elektrochemie*, Vol. 40, Nov. 1934, pages 814-821. Expansion coefficients of Ag (57.5°-860° C.), Cu (49.6°-825.7° C.), Ni (56.3°-664.8° C.), Pb (42.3°-295° C.), were determined in an apparatus using the change in capacity of an electric condenser as a measure of the change in length of a rod of the material being tested. The expansion of the rod changes the distance between the plates of the condenser and the potential (milli volts) necessary to bring the circuit into balance is converted to mm. change in length of the rod. The apparatus is checked before each test with a quartz rod as specimen. Materials before test were heated to the highest testing temperature for a short time. Pt-PtRh thermocouples were used for temperature measurements of the test piece. The curves for expansion coefficients versus temperature show a discontinuity only in the case of Ni at 356° C. which is near the Curie point. The authors suggest that this be regarded as third order transformation, the curve following the course of the specific heats. WB (12)

Creep of Heat-stressed Boiler Tubes (Das Kriechen wärmebeanspruchter Kesselrohre). KURT ADLOFF. *Die Wärme, Zeitschrift für Dampfkessel & Maschinenbetrieb*, Vol. 57, June 9, 1934, pages 369-374. Discusses the following factors: heat load of boiler tubes, calculation of resulting stresses, creep and its secondary effect upon the stresses in relation to time, creep resistance of modern boiler materials. The creep resistance (1% elongation in 100,000 hrs.) of a 0.2 C steel compares as follows with the creep resistance of Cr-Ni steels (18/8, 24/11, 24/20)

Carbon steel		Cr-Ni steels	
° C.	creep resistance kg./mm.²	° C.	creep resistance kg./mm.²
350	14.7	480	12.6
430	9.8	540	7.7
485	5.6	600	4.9
540	2.2	650	3.5
595	1.1	700	2.1
650	0.6	760	1.4
		820	0.7

The tendency towards scaling in plain C steel limits its use to relatively low temperatures, although calorizing minimizes this effect. Because of its immunity to oxidation the maximum service temperature limit of Cr steels changes as follows with rising Cr contents:

% Cr	° C.
12	675
16-18 (.5 Si max.)	870
16-18 (over .5 Si)	930
19-22	1010
28-30	1160

EF (12)

Creep Testing of Metals. ELBERT S. ROWLAND. *Mineral Industries, Pennsylvania State College*, Vol. 3, May 1934, page 4. Conclusion of general discussion. AHE (12)

Resistance of Materials at High Temperatures (La Résistance des Matériaux à Haute Température). H. J. TAPSELL. *Science et Industrie (Métaux et Machines)*, Vol. 18, July 1934, pages 202-206. The present section is devoted to the study of relation between flow and some other mechanical properties and to the endurance of steel at high temperatures. Following properties are studied. (1) Resistance to alternating stress (2) Resistance to pulsating stress (3) Endurance in a corrosive medium at high temperature (4) Impact tests on notched bars at high temperatures (5) Hardness at high temperature. FR (12)

Methods for Corrosion Study of Metals and Alloys in Gases (Methodes d'etudes de la corrosion des metaux et alliages par le gaz). A. PORTEVIN, E. PRETET & H. JOLIVET. *Revue Universelle des Mines*, Vol. 10, Oct. 15, 1934, pages 553-556. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 460. Ha (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Effect of Water on Selenium and Tellurium (Action de l'eau sur le sélénium et le tellure). E. MONTIGNIE. *Bulletin de la société chimique de France*, Vol. 5, Apr. 1934, pages 507-508. Se and Te react in different manner with H_2O according to their modification. Gray Se does not react with H_2O at 100° C. and 160°C. (6 atm.) at all while the red variety acts with H_2O according to $Se + 2\ H_2O = SeO_2 + 2\ H_2$ even at 50°C. Metallic Te covers with a white oxide in H_2O at 100° and 60°C. while freshly precipitated Te forms TeO_2 in contact with H_2O even at 50°C. EF (13)

Corrosion Troubles with Stainless Steel. P. MABB. *Mechanical World & Engineering Record*, Vol. 96, Aug. 3, 1934, pages 95-98. The corrosion-resisting properties can only be fully realized if care is taken at all stages of their fabrication into the finished product. The stainless steels are classified in two groups—those (martensitic structure) susceptible to hardening by heat treatment, and those susceptible to hardening by cold work (austenitic structure). Mechanical properties and chemical composition of several steels are tabulated. Applications, properties, and heat treatment of steels of the first group are discussed. To obtain the maximum resistance to corrosion of steels of the second group, consideration is given to their physical condition. The effect of surface inclusions produced by the mechanical operations to which the steel has been subjected during the rolling and drawing processes is discussed. When the steel is in a state of unequal strain a difference of potential is produced, and selective corrosion, under favorable conditions, takes place. Finishing cuts should be as light as possible to prevent the possibility of strained surface material. Hardening stresses may be reduced by heat treatment. Corrosion tests, the salt spray test and the humidity test are dealt with. Kz (13)

The Effect of Heat Treatment on the Corrosion of Magnesium-Zinc and Magnesium-Aluminium Alloys. TAKEJIRÔ MURAKAMI & SUSUMU MORIOKA. *Kinzoku no Kenkyu*, Vol. 11, March 20, 1934, pages 99-116. In Japanese. By dipping the specimens of Mg-Zn (less than 7.15% of Zn) and Mg-Al (less than 10.78% of Al) alloys in dilute NaCl solutions, the corrodibility of the alloys was tested as cast, annealed, quenched, or tempered, and the effects of these heat treatments on the corrodibility of these alloys have been studied. The effect of tempering on Mg-Al alloys is quite different from that on Mg-Zn alloys; in the former the corrodibility decreases with the increasing amount of separated second phase due to the tempering, while in the latter it increases. In the specimens of Mg-Al alloys tempered or annealed at certain temperatures, the troostitic or pearlitic structure appears; the alloys consisting of these structures are the most resistant to corrosion. This fact has been explained by anodic oxidation. In general, the resistance is the greatest in the cast state, both in Mg-Zn and Mg-Al alloys and it decreases by the application of heat treatment such as quenching, tempering or annealing. TM (13)

Galvanic Corrosion by Contact of Dissimilar Metals. C. L. HIPPENSTEEL. *Symposium on the Outdoor Weathering of Metals and Metallic Coatings. American Society for Testing Materials, Washington Regional Meeting*, Mar. 1934, 10 pages. A method of condensing and correlating the results of the galvanic couple corrosion tests of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys is presented. All couple combinations of Zn, Al, Fe, Pb, Sn, Ni, and Cu were subjected to outdoor exposure in 2 rural, 2 marine and 4 industrial locations. The metals tend to accelerate the corrosion of other metals with which they are coupled in roughly the following order: Ni, Sn, Cu, Fe, Pb, and Al. This rating was arrived at only by counting the total number of occasions when each metal appears as an accelerating agent. However it gives the impression that one should be more careful in the use of Cu, Ni and Sn coupled with the other metals. The metals may be rated from best to worst, according to their susceptibility to acceleration of corrosion by galvanic action as follows: Ni, Cu, Sn, Pb, Al, Zn, and Fe. Ni was not accelerated by coupling with other metals and Cu unaffected except at La Jolla (marine atmosphere) where it was accelerated by Ni but protected by the other metals except Fe. Sn and Pb might also be considered very nearly in the same class. Al probably comes next in its indifference to being coupled with the other metals except for its behavior in the marine atmospheres. Zn, while not accelerated so much as Al, shows some tendency to acceleration by coupling in a greater number of locations. Fe is accelerated to an appreciable extent in all locations by most of the metals. The greatest exception was Zn which afforded protection in all locations, the greatest protection being afforded in the severest exposures. VV (13)

The Harmony of Outdoor Weathering Tests. R. F. PASSANO. *Symposium on the Outdoor Weathering of Metals and Metallic Coatings, American Society for Testing Materials, Washington Regional Meeting*, Mar. 1934, 13 pages. The author reviews A. S. T. M. and other data on zinc and cadmium coatings and obtains the following conclusions. Zinc coatings of a given weight last longer than cadmium coatings of the same weight in localities where observations are available. The amount of zinc coating required for a given amount of protection on the outside varies widely with location. The underside of galvanized sheets on test racks is fairly well protected by a zinc coating. Zinc coatings furnish little protection to steel when moisture accumulates between the sheets in a pile. Uncoated steel sheets perforate from the underside on test racks. Increasing the thickness of steel sheets apparently increases their life by an amount which is greater than the increase in thickness would indicate. The severity of specific localities on zinc and steel is quite different. When the condensation is high, the condition at the laps is similar to that of sheets wet in a pile and it is there that failure is expected. VVK (13)

Some Notes and Observations on Petrol and Diesel Engines. H. R. Ricardo. *Institute of Marine Engineers*, Vol. 45, July 1933, pages 173-197. Includes discussion. Paper read before a joint meeting of the Institution of Automobile Engineers, the Institute of Marine Engineers, and other Societies, March 7, 1933. After a certain period of service, small cracks appear in the white-metal lining of the top half of the connecting-rod bearing, and spread gradually. The cause of the trouble is discussed and it is concluded: (1) that where the use of a hardened crankshaft is permitted, it becomes possible to employ harder bearing linings, such as lead bronze, gunmetal, or Duralumin, depending upon the difference in surface hardness between the crank and the bearing material; (2) where white-metal is used, it is best to employ very thin linings of the order of .010-.020" in separate thin steel shells. It might be possible to prevent trouble by making the pistons fairly heavy and the shank of the rod as resilient as possible in order to absorb the variant shocks. The connecting-rod should be made of an Al alloy rod with high elastic limit and low modulus. Light alloy rods and cast iron pistons have been successfully used, so far as immunity from cracking of the white-metal in the big-end bearing is concerned. Considerations concerning the problem of cylinder wear prove it to be doubtful that abrasion can be accounted for as the major factor. Observations in support of the belief that the greater part of the loss of metal from the cylinder liner is to be accounted for by direct corrosion by products of partial combustion, are discussed. Surface hardened materials showed a greater rate of wear than cast iron. It will be the task of the metallurgist to find a cylinder liner material which is corrosion resistant and it is said that a high Cr and P content appears to be useful. It is mentioned that by increasing the P content of the Fe from 0.2-0.6% with no other changes, the cylinder wear can be improved by approximately 30-40%. Kz (13)

Theory of Passivity Phenomena. XXII. (Zur Theorie der Passivitätserscheinungen. XXII). Wolf Johannes Mueller. *Zeitschrift für Elektrochemie*, Vol. 40, Mar. 1934. pages 119-125. Experimental and theoretical bases for explanation of passivity phenomena in metals are reviewed. Cover passivity and chemical passivity are distinguished. The former exists when, in the course of electrolysis, the dissolving process remains the same, more exactly when only one valency stage dissolves; this is the case for all metals with only one or more valencies. The theory of the covering passivity is applied to the passivation of Fe by HNO_3, to corrosion passivity and to activation which latter occurs logically if the protective cover is more or less removed, so that the metal is dissolved. This is always the case if the pores of the protective layer exceed about 10^{-2} cm.^{2} per cm.^{2} in size. The cover passivity theory shows that the passive condition is determined by the existence of a protective layer which for an area of 1 cm.^{2} has a porous surface of not more than about 10^{-4} cm.^{2}; if this layer is stable the metal will not dissolve spontaneously nor anodically. The methods for measuring the degree of covering by evaluating the current-time curves are explained. The new definition explains all former quantities as passivating current, degree of passivity, stability of passivation, means for passivation, etc., on a common basis. 21 references. Ha (13)

Theory of Passivity Phenomena. XXIV. Covering Passivity and Chemical Passivity in Anodic Treatment of Iron in Sulphuric Acid. (Zur Theorie der Passivitätserscheinungen. XXIV. Ueber Bedeckungspassivität und chemische Passivität bei anodischer Behandlung von Eisen in Schwefelsäure). W. J. Müller & E. Löw. *Zeitschrift für Elektrochemie*, Vol. 40, Aug. 1934, pages 570-578. **XXV. Chemical Passivity and Its Electron-Theoretical Explanation (Ueber chemische Passivität und ihre elektrontheoretische Bedeutung).** W. J. Müller. Pages 578-582. The state of passivity in a metal is due primarily to a layer of salt formed by the dissolving metal ions and covering the surface of the metal. 2 definite kinds of anodic passivity are distinguished: if, after formation of the salt layer, i.e. after reaching the passive state, the metal still dissolves with its normal valency, the condition is defined as covering passivity. If, after passivity having been established, a new process starts consisting either in a dissolving of the metal in a higher valency, or if development of oxygen begins at the electrode, the condition is defined as chemical passivity. Anodic passivation of Fe in H_2SO_4 produces both covering and chemical passivity consisting in first forming a layer of iron sulphate heptahydrate which, after passivation, is transformed into a polarizing layer. Fe goes into solution with various valencies according to voltage applied: up to 0.7 volt as bivalent Fe, from 0.8 to 1.4 volt as trivalent Fe, and above 1.4 up to 1.7 volt anodic O development takes place besides dissolution whereby the previously dissolved Fe is oxidized. The original, crystallized covering salt layer is strongly birefringent and is transformed below 0.5 volt into a layer of basic, water-soluble salt; above 0.5 volt, the layer transforms into a completely translucent oxide layer. Anodic passivation never produces completely homogeneous layers, pores exist in which the metal even in the state of covering passivation dissolves with normal valency. Chemical passivity, according to its definition, occurs only in metals which exist in more than one valency. The valency with which a metal dissolves is constant as long as configuration of the electrons is constant; in this case the potential of metal conforms to Nernst's law. Experiments made with Fe, Ni, Pb, etc., corroborate these explanations. 11 references. Ha (13)

Study of the Passivity of Iron and Steel in Nitric Acid Solution. (Report II). Yôichi Yamamoto. *Bulletin, Institute of Physical & Chemical Research, Tokyo*, Vol. 13, June 1934, pages 616-640. In Japanese. *Abstracts & Scientific Papers, Institute of Physical & Chemical Research, Tokyo*, Vol. 24, June 1934, pages 34-36. In English. A study of the sudden transition of soft steel with 0.15 C, 0.14 Si, 0.51 Mn, 0.037 P, and 0.025 S to the active state through heating in HNO_3 was made. In 48-60% solutions, the samples passed from the passive state directly to the state of violent dissolution above 72°C. In HNO_3 of 60-75%, 2 sudden changes were observed. The first entails a temporary activation, the second one represents a violent complete activation. The transition temperatures rise with increasing concentrations. Samples did not become completely active even at the boiling temperature of the acid in the concentration range of 75-100%. It was furthermore established that the activation temperature was slightly raised if the temperature rise was rapid. (See also *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 281 L 10.) WH (13)

Polarographic Investigations of Passivity. Part I—The "Activation" and "Passivation Potential" of Iron. Otto H. Muller. *Collection of Czechoslovak Chemical Communications*, Vol. 6, June 1934, pages 268-282. The advantages of the "polarograph" for the investigation of passivity of metals are described. The fundamental advantage of this apparatus is the automatic registration of current-voltage curves. The applied electromotive force is increased or decreased steadily by a motor-generator, the rate of which can be regulated. The current flowing through the electrolytic cell is registered by a suitable shunted galvanometer with a short period of swing (or oscillograph) which reflects a beam of light upon a moving photographic paper. Light flashes at regular intervals produce lines on the so-called "polarograms" indicating the corresponding applied electromotive force. Results with iron have shown the following: The difference of the passivation and activation voltages, E, observed when the cell has considerable resistance, R, can be explained by the relation $\pi = E - iR$ where π means the "activation" or the "passivation potential" current voltage curves, using a non-polarizable reference electrode and the iron electrode, show one fall in current in HNO_3, two falls in current in H_2SO_4, and three falls in current in H_2PO_4, which are considered to be due to the different anions of these acids. Passivity curves can be obtained by starting with cathodic polarization and decreasing the polarizing e.m.f. down to zero, the sign and magnitude of the polarizing e.m.f. depending entirely on the potential of the non-polarizable reference electrode used. Periodic phenomena can be produced at will with desired time intervals of oscillation. GTM (13)

Doing things with DURIRON

MERRIMAC CHEMICAL COMPANY
SUBSIDIARY OF
Monsanto Chemical Company
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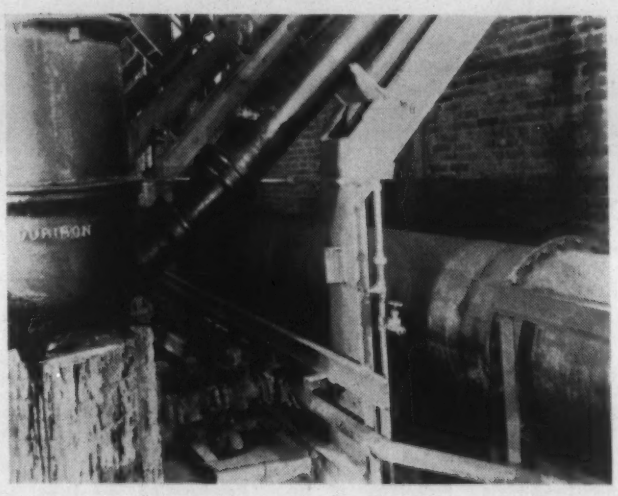
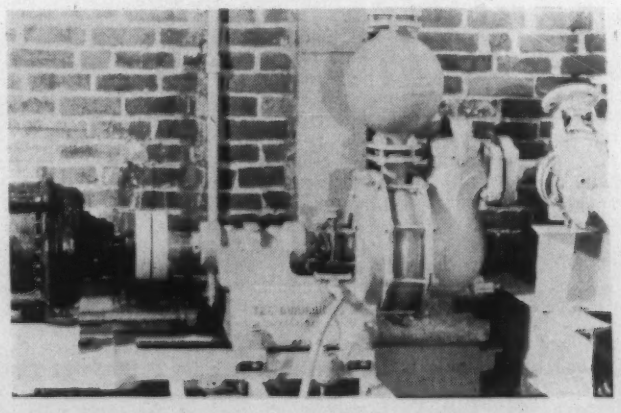
Nitric Acid

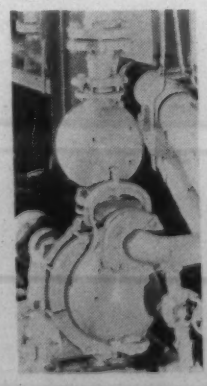


These Duriron towers and 8 in. Duriron lines are installed in the Nitric Acid Plant of the Merrimac Chemical Company. The valves and flanges were transferred from another plant and are almost ten years old. The Duriron pipe was welded in place to make the offset.

Sulphuric Acid



This Duriron self-priming pump, Type D2GS-9½, is used for unloading tank cars of sulphuric acid, transferring the acid to storage, and from storage to mixing tanks, one pump serving both purposes—an economical layout.



Aluminum Sulphate

Duriron self-priming pump, Type D2GS-10½, is used for transferring aluminum sulphite, and has proved very satisfactory, they state.

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THE DURIRON COMPANY, Inc.
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The Influence of Rainfall and Smoke on the Corrosion of Iron and Steel. G. N. Schramm & E. S. Taylerson. *Symposium on the Outdoor Weathering of Metals and Metallic Coatings. American Society for Testing Materials Washington Regional Meeting*, Mar. 1934, 12 pages. A total of 774 sheet samples was exposed to atmospheric conditions in six groups at each of three locations, Kearny, N. J., Vandergrift, Pa., and South Bend, Pa., for a period of one year, the initial exposure of each group occurring at intervals of two months. 2 copper steels, 2 copper irons, 2 plain steels, 2 plain irons and 1 wrought iron were exposed. The data obtained indicate that (a) samples exposed for a period of one year beginning Mar. 1, May 1, and July 1, rust less than those initially exposed Sept. 1, Nov. 1, and Jan. 1; (b) some ordinary ferrous materials are consistently more resistant to industrial and rural atmospheric corrosion than others; and (c) the order of merit of the compared materials changes somewhat depending upon the season of the year in which they were initially exposed. No direct relationship was found between corrosion and amount of rainfall. This was confirmed by two other sets of data. The amount of corrosion was roughly proportional to air pollution as measured by fuel consumption. This relationship held in two sets of data but did not hold in a third set. Factors which probably determine the rate of corrosion of a steel in the atmosphere are seasonal changes in natural atmospheric conditions, the extent and kind of atmospheric pollution, the length of time the object remains wet, the conditions favorable to the absorption of atmospheric impurities, the intermittent removal of water-soluble salts by heavy rainfall, and the presence of condensed moisture in the rust film. VVK (13)

Influence of Oxide Films on the Wear of Steels. Samuel J. Rosenberg & Louis Jordan. *Bureau of Standards Journal of Research*, Vol. 13, Aug. 1934, pages 267-280. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540. WAT (13)

Rapid Test of Electrochemical Corrosion of Soldered Joints (Essais Rapides des Assemblages Soudees). A. Roux. *Usine*, Vol. 43, July 19, 1934, page 37. See "Rapid Method for Determining Electro-Chemical Corrosion of Welded Joints," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540. Ha (13)

Wear Resistant Castings for Chemical Equipment (Verschleissfester Guss im chemischen Apparatebau). K. Roesch & A. Clauberg. *Die Chemische Fabrick*, Vol. 7, Aug. 22, 1934, pages 297-300. For the most severe service, such as wearing parts of crushing machinery, austenitic Mn steel is best. It hardens by cold working. It can be ground, but not machined except with cemented carbide tools. Heat treated Cr-Ni and Cr-Ni-Mo steels are also used. The cheapest wear resisting castings are white iron containing about 3% C and .5% Si. They are brittle and cannot be machined. Their wear resistance is due to Fe_3C. White iron is used mostly for small parts. Case hardened low C steel has good wear resistance and the advantage of a tough core. The relative wear resistance of these materials depends on the service, pressure, and other conditions. Mn steel is not very good when the pressure is low. Under corrosive conditions hardened Cr steel and 14% Si iron castings are especially good. Laboratory tests should be supplemented by service trials. CEM (13)

Subaqueous Corrosion Protection of Iron (Bescherming van ijzer tegen corrosie onder water). H. A. J. Pieters & J. Mannens. *Polytechnisch Weekblad*, Vol. 28, May 3, 1934, pages 278-280. Based on the observation that oils tend to adhere to metals to a greater degree than water, extensive laboratory tests are carried out to determine quantitatively the possibility of corrosion protection of Fe due to surface films of oils. For details consult the original paper which collects the experimental results on 14 different series (8-15 oils or oil mixtures each) in 16 tables. There are possibilities of treating Fe with various kinds of oil in such a manner as to check the corrosion attack of (aerated) water. Particularly favorable results were obtained with resinous oils, linseed oil and oils which contained resins in solution. Oil emulsions (with at least 5% by vol.) as utilized in drilling are equally rust inhibiting with respect to water saturated with air. EF (13)

Use of Cement in Protecting Underground Pipe Lines Against Corrosive Action of Soils. J. H. Peper. *Oil & Gas Journal*, Vol. 32, Jan. 4, 1934, pages 9-10 **Specifications Covering Material and Equipment Needed for Coating Pipe Lines With Cement.** *Oil & Gas Journal*, Vol. 32, Feb. 1, 1934, pages 34-35. Advantages of using cement for protecting pipe lines are (1) There is no time lost in its application while waiting for proper weather conditions since it can be applied in all but freezing weather. (2) Reconditioning with cement can be done without taking the line out of service. (3) It is not necessary to clean a line as thoroughly when using cement as when a primer is to be applied. (4) Cement has high corrosion inhibitive qualities and acts toward the arresting of corrosive action. (5) There is less danger of injury to men when using cement than when using hot bitumens. (6) Cement coatings are protective against oil-soaked soil. Cement coatings have developed along the lines of the use of permanent forms or semi-permanent forms, cement gun applications, removable forms for applying a thin cement coating and machine wrapped cement coatings. The second article deals with the equipment necessary for the application of cement to pipe lines. VVK (13)

Corrosion and Corrosion Resistant Alloys for the Cellulose and Paper Industry (Korrosion und korrosionsbeständige Legierungen für die Zellstoff-und Papierindustrie). Fritz Ohl. *Die Metallbörse*, Vol. 24, May 23, 1934, pages 645-647; June 6, 1934, page 714. Cast Fe is rapidly attacked in the wood pulp industry. Ni stands up well and induces this corrosion resistance into other alloys including cast Fe. Cr acts similarly to Ni. The best results are obtained at Cr contents of 15-25%. Mo, Al and Ti are furthermore considered as alloying elements for structural materials in the industry discussed. The favorable results gained on 4 Cr-Ni bearing alloys with (1) 80 Ni and 14-20% Cr. (2) 60 Ni and 15 Cr, (3) 18/8 and (4) 18/8 containing 3% Mo in 30 different chemical reagents (for some concentration and temperature ranges are given) are assembled in a large chart. The corrosion stability of various alloys in sulphite plants has been tested. A gas containing 17-18% SO_2 and 1-2% O_2+SO_3 was used at 200°-220°C. 18/8 and 23/11 proved to be particularly corrosion resistant. The same holds for alloys with still higher Ni-Cr contents although the latter offer some difficulties due to their physical properties. American specifications on cast steel for sulphite pulp plants are given as 20% Cr, 9% Ni, C < .01% of the Cr content, < .05% S, < .05% P. The Si and Mn content can be varied by the manufacturer and the choice of 2-4% W is open to the customer. EF (13)

On the Resistance of Nitrided Austenitic Manganese Steel against Sea-water Corrosion. Shun-ichi Sato. *Bulletin Institute of Physical & Chemical Research, Tokyo*, Vol. 13, July 1934, pages 792-797. (In English.) *Abstracts & Scientific Papers Institute of Physical & Chemical Research, Tokyo*, Vol. 24, July 1934, pages 42-43. In English. The single potential differences of various nitrided steels were measured in sea water. Nitralloy containing Ni proved to be more resistant. The potential of nitrided austenitic Mn steel rose during the exposure to sea water. Absolute freedom from rusting and self healing ability of this steel was noticed. Change of hardness and microstructure has also been studied. WH (13)

Valve Seat Wear. C. G. Williams. *Automobile Engineer*, Vol. 24, June 1934, pages 219-221; July 1934, pages 240-248. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 463. Ha (13)

Corrosion Results in an Experimental Boiler. Thorwald A. Solberg & R. C. Adams. *Mechanical World & Engineering Record*, Vol. 96, Aug. 17, 1934, pages 145-146. See "A New Boiler-Water Treatment for the United States Navy," *Metals & Alloys*, Vol. 5, June 1934, page MA 294. Kz (13)

Attack of Sulphur-Containing Fuel Gases on Metallic Retorts (Der Angriff schwefelhaltiger Brenngase auf Metallretorten). B. Waeser. *Werkstoffe & Korrosion*, Vol. 9, Sept. 25, 1934, pages 33-34. The injurious effect of S compounds on metals and their sources according to kind of combustion of a gas are explained. Oxidizing flames containing sulphurous acid attack Fe and Fe alloys considerably even at moderate temperatures of 400° to 600° C. Ni in the alloy accelerates the attack. Steels with 12-20% Cr have a good resistance against moist H_2S gas at 500° C. but high Ni content counteracts the good effect of Cr. According to recent investigations the following conditions were found:

Kind of steel	corrosion-proof against H_2S/H_2 up to
unalloyed SM steel	80° C.
low-alloy Cr-Ni steel	100
low-alloy Cr-V steel	150
low-alloy (Cr)-Mo steel	150/200
Cr-Ni steel (about 13% Cr)	250
Ni-Cr-Fe alloy	200
Ni-Cr-Fe-Mo alloy (60% Ni)	350
high-alloy Cr-Ni steel (about 20% Cr)	325
high-alloy Cr cast iron	375

These values can be applied in general also for reducing flames. The latter should be avoided; if this is not possible, CO and CO_2 in the gas should be reduced to the lowest possible degree and a high-alloy, Ni-free material for the apparatus be used. The S containing corrosion layer which is formed on the surface does not constitute a permanent protection, the attack progresses under the layer. 4 references. Ha (13)

Outline of Stray Current Electrolysis. Ira D. Van Giesen. *Journal American Water Works Association*, Vol. 26, May, 1934, pages 653-671. Fundamentals of electrolytic corrosion are covered. Stray current electrolysis from street railway systems and the remedies to be applied are then discussed in detail. VVK (13)

Influence of Heat-Treatment of Hardenable Aluminum Rolling Alloys on the Corrosion Resistance to Sea Water (Beitrag zur Frage des Einflusses der Wärmebehandlung aushärtbarer Aluminium-Walzlegierungen auf die Korrosionsbeständigkeit gegen Seewasser). O. Summa. *Korrosion & Metallschutz*, Vol. 10, Mar. 1934, pages 57-58. Fundamental condition for refinability is existence of a supersaturated solid solution from which, either in course of time or through the action of temperature and pressure a precipitation takes place. This transformation in the solid state can consist either in a change of the lattice symmetry or in the rearrangement of atoms. This requires a certain time and depends on the free energy of certain freely moving electrons. Refinement can occur either in a group of properties which are influenced mainly by the mobility of electrons, e.g. electric conductivity, electric potential; or in a group of properties depending mainly on arrangement of atoms, e.g. hardness, strength; a 3rd group of properties is influenced alternately by atom and electron arrangement, e.g. corrosion. The latter was investigated more closely. Corrosion phenomena proceed only under the action of definite potential differences at the various places of the border surface metal/solution. Specimens aged at room temperature showed that the grain of the solid solution forms the anode while the grain boundaries are cathodic. Under heat-treatment at medium temperatures the regrouping of atoms becomes more pronounced, and the grain becomes cathodic, while the now anodic grain boundaries are strongly attacked. At 180° C. an agglomeration of $CuAl_2$ particles takes place. Ha (13)

Physico-Chemical Considerations on the Formation of Boiler Incrustations (Physikalisch-chemische Betrachtungen über die Kesselsteinbildung). Robert Stumper. *Zeitschrift für Dampfkessel & Machinenbetrieb, Die Wärme*, Vol. 57, May 5, 1934, pages 289-292; May 19, 1934, pages 324-328. A special chapter is devoted to the corrosion attack of the boiler material underneath linings. The main reactions are $Fe + H_2O \rightleftarrows FeO + H_2$ and $2\,Fe + 3\,H_2O \rightleftarrows Fe_2O_3 + 3\,H_2$. Above 500°C. the boiler incrustations react with its metallic carrier. Due to dissociation effects, chemical compounds are formed which accelerate the oxidation of Fe. Among these compounds, nitrates, organic substances, and carbonates are prominent followed by certain chlorides (mainly of Mg and Fe) and sulphates. Mohr recently proved the formation of H_2S due to a reaction between H_2 and gypsum or Na-sulphate. The H_2S liberated strongly promotes corrosion attack. The Baumann test for S segregates clearly reveals the presence of Fe-sulphur compounds in boiler tubes. Typical pictures of defective boiler materials are shown. EF (13)

Big Soap Plant Continually Develops New Uses for Metallizing. Charles K. Stipp. *Metallizer*, Vol. 2, Aug. 1934, page 7. Zinc, tin, lead, cadmium and monel metal have been used with marked success in metallizing soap plant equipment to prevent corrosion and contamination of products. BWG (13)

Cylinder Wear. C. G. Williams. *Automobile Engineer*, Vol. 24, Oct. 1934, pages 367-369. The report of the Research and Standardization Committee of the (British) Institution of Automobile Engineers deals with acids responsible for corrosion of cylinder walls and piston rings; the possibility of HNO_3, H_2SO_4 and CO_2 being formed from fuels and combustion products is discussed. Addition of CO_2 increased the rate of wear appreciably, and rate of wear increased considerably with load. H_2SO_4 did not seem to have an important effect, but this depended largely on the S content of the fuel used. The accelerated wear at low temperatures is due mainly to corrosion by the 3 investigated acids, but at elevated temperatures where practically no moisture is present to form them, this corrosion stops. Organic acids did not cause any corrosion at high cylinder temperatures. Upper cylinder lubrication proved effective only when starting from cold, but not under continuous running conditions. Tests are described in detail. Ha (13)

Attack of Metals by Organic Liquid Binary Systems (Das Angriffsvermögen organischer flüssiger binarer Systeme auf Metalle). Ljudevit Sladovic. *Monatshefte für Chemie*, Vol. 64, March 1934, pages 35-40. The loss of weight of samples of Fe, Al and Cu after immersion for 3 to 4 weeks at 45° to 60°C. in a large number of organic liquids individually, and 1:1 mixtures of liquids, was determined. Fe and Al showed no noticeable corrosion. Cu corroded considerably in some of the liquids. In cases where the 2 liquids formed a compound when mixed, the mixtures corroded Cu more than either of the liquids alone. In cases where they did not form compounds, the mixture corroded Cu less than the more corrosive liquid alone. CEM (13)

Corrosion of Bridges by Smoke (Rauchgasanfressungen an Flussbrücken). R. Liebetanz. *Der Bautenschutz*, Vol. 5, July 1934, pages 85-88. Discussion of damage to the Rhein-bridge at Düsseldorf, caused by the smoke of river-boats. Chemical processes which take place from the moment of the combustion of the S content of the fuel up to the formation of the crusts on the steel of the bridge are dealt with. To prevent damage the author advises (1) the application of certain corrosion resisting steels (containing Cr and Cu), (2) changes in construction and careful working of the construction parts, (3) the application of corrosion resisting coatings. Discussing different kinds of coatings it is pointed out that good results have been obtained by the use of artificial resin products and P-solutions which are sprayed on to the steel before the application of paints. Kz (13)

The Corrosion of Tin and its Alloys. Part I. The Tin-rich Tin-antimony-copper Alloys. T. P. Hoar. *Technical Publications of the International Tin Research and Development Council*, Series A. No. 4, 1934, 14 pages. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540. (13)

Methods of Testing Corrosion and Their Respective Fields of Application (Méthodes d'Essais de Corrosion; leurs Domaines réspectifs d'Utilisation). HERZOG. *Usine*, Vol. 43, Oct. 18, 1934, page 37. Direct optical, gravimetric, mechanical and electrical methods, and indirect electrochemical methods to measure degree of corrosion, and the conditions which determine the selection of one or the other or a combination of them are discussed. Ha (13)

Copper and its Oxide Protection (Das Kupfer und sein oxydischer Schutz). L. W. HAASE. *Die Chemische Fabrik*, Vol. 7, Sept. 19, 1934, pages 329-330. Cu is covered with a natural patina when exposed or it can be artificially colored, but the colorings do not protect it against corrosion. Protection is given by oxide coatings with or without coloring. The composition of the oxide layer changes gradually from 100% Cu through a mixture of Cu and Cu_2O to 100% Cu_2O at the outside surface. Protective oxide coats are produced naturally by rain water and artificially by solutions of salts of oxidizing acids. Cu_2O layers .0025 to .0035 mm. thick can be produced which will protect the Cu for years. CEM (13)

Air Velocity—Not Tip Speed—Affects Fan-Blade Erosion. A. A. CRIQUI. *Power*, Vol. 78, Apr. 1934, page 195. AHE (13)

The Rate of Solution of Magnesium in Acids. MARTIN KILPATRICK & J. HENRY RUSHTON. *Journal of Physical Chemistry*, Vol. 38, Mar. 1934, pages 269-306. Rates of solution of Mg in aqueous solutions of acids have been determined by 4 different experimental methods. Results were found to be reproducible and in agreement for the different samples of Mg. The kinetic law for the reaction has been derived and tested over the whole course of the reaction. The general kinetic quation is

$$v = k_1CH_2O + k_2CH_3O + k_3CA + \ldots\ldots \text{ etc.}$$

where A represents an acid other than the H_3O^+ or water. For strong acids the primary reaction is with the H_3O^+ ion. For weak acids the rate of reaction is not proportional to the H-ion concentration but rather the increase in rate is proportional to the concentration of the acid present. A relation has been found between the surface speed of the metal and the rate of its reaction. The effect of viscosity has been investigated. The temperature coefficient has been determined for the water reaction, the H_3O^+ ion, and the molecular acetic acid reaction. The results are discussed from the standpoint of the diffusion theory and the Brönsted-Kilpatrick theory. The results are not definitely in agreement with the "old diffusion theory" but may be brought in terms of a modified diffusion theory based on the extended theory of acids. However any modification must account for the water reaction. On the basis of the Brönsted-Kilpatrick theory the velocity constants have been related to the acid strength. Experiments on the dissolution of Zn in HCl and acetic acid were carried out under the same testing conditions as with Mg. After an induction period of 20-25 min. the H_2 evolution followed the same law as in the case of Mg. See also *Metals & Alloys*, Vol. 2, Aug. 1931. page 141. EF (13)

Why Does Iron Rust and What Prevents Rusting of Stainless Steels? (Warum rosted Eisen und was verhindert das Rosten bei den rostfreien Stählen?) W. J. MÜLLER. *Die Chemiker Zeitung*, Vol. 58, Sept. 29, 1934 pages 789-791. Rusting is caused primarily by the enlargement of the surface of Fe by the colloidal-chemical solution of the natural oxide layer on the Fe. If the pore size of a layer of oxide in contact with an electrolyte stays below 10^{-3} or 10^{-4} cm.³/cm.³, then the metal does not corrode in that medium. If it enlarges to 10^{-2} or more the metal corrodes. 9 references. CEM (13)

Optical Investigations on the Problem of Passivity of Metals II. The Naturally Occurring Oxide Film on Polished Iron Mirrors (Optische Untersuchungen zur Frage der Passivität der Metalle II. Die natürliche Oxydschicht an polierten Eisenspiegeln). L. TRONSTAD & T. HÖVERSTAD. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 170, Oct. 1934, pages 172-190. Two different methods of removing the natural oxide layer on polished Fe mirrors (.04% C, .06% Si, .04% Mn, .005% P, .018% S) have been experimented with and by polarisation-optical measurements the thin surface film possessed a mean thickness of about 20 A.U. Consequently the oxide layer cannot be considered any longer as a mono-molecular oxide film (Langmuir). It represents a tridimensional arrangement of more or less hydrated oxide which also occurs as a passifying layer in strong nitric and chromic acid. The thickness of the surface layer occurring on anodic passification in 1 N Na_2SO_4 is approximately 50-70 A.U. and has a refraction index of about 35. The former divergencies between the measurements of Müller & Machu (*Zeitschrift für physikalische Chemie*, 1933, page 357), and the author's optical determinations on the removal of the oxide layer are eliminated by a study of the properties of the air layer in contact with the Fe mirror. EF (13)

Cracking of Nickel-plated Brass Objects; Causes and Their Elimination (Das Aufreissen vernickelter Messinggegenstände, ermittelte Ursachen und ihre Beseitigung). H. REININGER. *Metallwaren Industrie & Galvanotechnik*, Vol. 34, Mar. 29, 1934, pages 143-144; Apr. 14, 1934, pages 163-165; May 15, 1934, pages 211-213. Internal stresses due to cold working are blamed for the cracking of Ni-plated brass objects. Surface inhomogeneities accentuate this tendency due to their notch-effect. Even minute grooves due to turning, brushing, etc., are detrimental. In these grooves small quantities of grinding and polishing materials, of pickling and electrolytic baths are easily retained and result in corrosion defects starting at these contaminated spots. Soft annealed brass sheets in which the crystals of the Cu-rich α solid solution predominate should be used exclusively for objects submitted to drawing or pressing. Intermediary annealings are eventually required to release internal stresses. EF (13)

Rusting Experiments on Iron Wire (Rostversuch an Eisendraht). SALLER. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 89, Aug. 15, 1934, page 313. Tests on 12 Fe wires with 0.03-0.12% C (complete analyses given) in a Swedish Research Institution with the object of determining the suitability of these materials as telegraph wire and in particular their resistance against rusting. Corrosion was measured after 9, 12, 24 and 48 months by electric conductivity determinations. Open-hearth and electro-steel containing 0.15 and 0.3% Cu, exhibited the lowest corrosion attack, i.e. a resistance increase of 5.5-6.5% whereas open hearth and electro-steel low in C (.03-.04% C) suffered the greatest corrosion attack, namely a resistance increase of 10.3-12.2%. Regarding the specific electric resistance, only the 2 Cu-bearing irons met the specifications. All of the wires met the tensile strengths requirements. However 2 Lancashire steels failed in torsion tests. WH (13)

Corrosion of Metal Fastenings in Zinc-Chloride-Treated Wood. R. H. BAECHLER. *Industrial & Engineering Chemistry*, Vol. 26, Dec. 1934, pages 1336-1338. It seems inadvisable to use wire nails in $ZnCl_2$-treated wood that is to be exposed to very humid conditions. The corrosion of brass and galvanized Fe fastenings in similar wood is probably slight under all conditions of humidity. MEH (13)

1 **Effect of Nitrocellulose Solutions Upon Different Materials (Einwirkung der Nitrozelluloselösungen auf verschiedene Materialien).** S. SKLJARENKO, A. PAKSCHWER & O. GELIKONOWA. *Korrosion & Metallschutz*, Vol. 10, Sept. 1934, pages 217-222. Investigation of the corroding effects of nitrocellulose solutions on metals as used in artificial silk manufacture showed that presence of water and free acids (HNO_3 and H_2SO_4) is the prime factor; metals will not corrode in water-free agents. Nitrocellulose strongly reduces the velocity of corrosion as it participates in forming protective films. The rate of corrosion is not materially changed by temperatures between 20° and 30° C. A chemical change in nitrocellulose during reaction does not take place. Rubber, ebonite, and similar materials in such solutions behave quite differently from metals. Ha (13)

2 **Corroding Effect of Asbestos on Nickel and Its Alloys I (Über die korrodierende Einwirkung von Asbest auf Nickel und dessen Legierungen I).** E. SCHÜRMANN & WILH. ESCH. *Kautschuck*, Vol. 10, July 1934, pages 101-104; Aug. 1934, pages 119-121. Resistance wires in contact with asbestos containing insulation material were corroded. Microscopic investigations of raw asbestos disclosed the presence of minute shining particles of magnetite which in most cases were accompanied by pyrite, scattered in between the individual fibers. A study of the reaction of pyrite on Ni was made. No attack on Ni was noticed if moisture was absent. Atmospheric humidity and catalytic action of the water-soluble salts always present in asbestos are responsible for the corrosion attack of pyrite on Ni whereby Ni sulphates are formed. If pyrite is absent in asbestos, the neutral salts are unable to initiate corrosion. Part of the total Fe present in asbestos is due to Fe-oxides which are harmless. Testing of asbestos must, consequently, be focussed on the presence of pyrite. EF (13)

3 **Corrosion in the Petroleum Industry.** O. A. KNIGHT. *Mineral Industries, Pennsylvania State College*, Vol. 4, Nov. 1934, page 4. Corrosion is caused by S in oil, high temperatures of treatment, and chemicals used in refining (such as H_2SO_4). Methods for minimizing these various types of corrosion are discussed briefly. AHE (13)

4 **A Reflectivity Method for Measuring the Tarnishing of Highly-polished Metals.** L. KENWORTHY & J. M. WALDRAM. *Technical Publication of the International Tin Research & Development Council.* Series A, No. 11, 10 pages. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540. HWG (13)

Passage of Hydrogen Through Steel. T. N. MORRIS. *Nature*, Vol. 133, Feb. 10, 1934, pages 217-218. In experiments on corrosion of mild steel in citric acid at 25° C., hydrogen was found to be absorbed in the steel and to pass through it. CSB (13)

5 **Effect of Manganese on the Corrosion of Magnesium (Einfluss des Mangans auf die Korrosion von Magnesium).** W. O. KROENIG & S. E. PAWLOW. *Korrosion & Metallschutz*, Vol. 10, Nov. 1934, pages 254-263. The increased resistance to corrosion of Mg-Mn alloys in water as compared with Mg is due to the protective action of a film of $Mn(OH)_2$ which forms on the surface; this film is, in time, transformed into $MnO_2.H_2O$ by the O in the water. The microscopic examination of the corrosion phenomenon shows that corrosion begins at places furthest from inclusions and which are the most anodic. A film is formed and protects this place from further corrosion. The metallographic examination showed that due to the partial solution of magnesium hydroxide formed during corrosion the latter becomes able to absorb CO_2 from the air so that magnesium carbonates are formed which dissolve in the water and also exert a protective action. 9 references. Ha (13)

6 **Causes and Prevention of Rusting of Cutlery (Ursache und Bekämpfung der Rostbildung bei Messerschmiedewaren).** R. PLÜCKER. *Korrosion & Metallschutz*, Vol. 10, Oct. 1934, pages 241-242. Rusting of cutlery, even of so-called rustless steels, is due to impurities, especially S, P, Mn, Si and slag, which form local elements on the surface under moisture; the electrolytically dissolved metal is oxidized (rusts) by the O of the air. A very good resistance to rusting is obtained by a high polish which forms a solid, dense, continuous oxide film which protects the underlying metal as long as it is not mechanically or chemically destroyed. A cleaning powder which does not attack a good polish is a mixture of 3 parts citric acid, 2 parts polishing red (rouge), 1 part finest emery, and 2 parts chalk; to be used with water. Ag- or Ni-plated ware should be cleaned with a mixture of 30 parts liquid ammonia, 30 parts whiting, 45 parts alcohol. Ha (13)

7 **Theory of Passivity Phenomena XXII. Further Investigations into the Passivity of Lead (Zur Theorie der Passivitätserscheinungen XXII. Weitere Untersuchungen über die Passivität des Bleies).** W. J. MÜLLER & W. MACHU. *Sitzungsberichte der Wiener Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse*, Abt. II B, Vol. 42, No. 9, 933, pages 557-577. The present paper confirms the most important previous experimental results on the passivity of Pb. The i_0t_p curve for a Pb surface cathodically prepared to a sufficient degree yielded current intensity-time curves corresponding to the following equations: $\log t_o = -1.384 + 1.616 \log \frac{i_o}{F_o}$ and $\log t_p = -0.767 + 0.872 \log \frac{i_o}{F_o}$ with reference to respectively the following ranges 1.22 — 0.03 amps./cm.² and 0.03 — 0.003 amps./cm.² Evaluation of the current intensity-time curves yielded a conductivity in the pores of the protective layer of 40×10^{-6} — 500×10^{-6} ohms or 20,000 times lower than the conductivity of the electrolyte (storage battery acid). The free surface at the moment of passification is 10^{-2} — 10^{-3} cm.² Depending on the potential of Pb, 2 phenomena occur at the metal surface. The normal solution process $Pb \longrightarrow Pb\cdot\cdot$ corresponds to a Pb potential of —0.3 volts and to an electrode potential of up to about 1.8 volts, the latter being raised by the polarisation of the protective layer. The phenomenon in H_2SO_4 entails a $PbSO_4$ coat on the metal. At an electrode potential of approximately over 2 volts a Pb potential of +1.8 volts occurs corresponding to the reaction $Pb \longrightarrow Pb\cdot\cdot\cdot\cdot$. The latter goes into solution and hydrolyzes according to the equation $Pb\cdot\cdot\cdot\cdot + 2H_2O \longrightarrow PbO_2 + 4H$ whereby the original $PbSO_4$ surface layer changes into PbO_2. (See also *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 83 R6.) WH (13)

8 9 10

14. APPLICATION OF METALS AND ALLOYS

Utilization of Metals and Alloys in the Sulphuric Acid Industry (Die Verwendung von Metallen und Metall-Legierungen in der Schwefelsäureindustrie). BRUNO WAESER. *Die Metallbörse*, Vol. 24, Oct. 10, 1934, pages 1289-1290; Oct. 17, 1934, pages 1321-1323; Oct. 24, 1934, pages 1353-1354. Discusses at length the corrosion resistance of Pb (effect of various impurities) Pt, Au, cast Fe, Cr, Ni, Cr-Ni steels, Ni bearing cast Fe, Monel metal, high Si cast Fe. Briefly considers Ta, Al bronze, pure Al, Silumin. Data on weight losses of various materials with respect to different H_2SO_4 concentrations are presented in 12 tables and 21 references are included. EF (14)

Aluminum Cables with Steel Reinforcement for Medium Voltage Transmission Lines (Aluminiumseil mit Kerndraht aus Stahl für Mittelspannungsleitungen). H. SCHMITT & P. BEHRENS. *Elektrizitätswirtschaft*, Vol. 33, Oct. 25, 1934, pages 423-426. Paper before the Annual Meeting of the Reichsverband der Elektrizitätsversorgung 1934, critically discusses the utilization of Al for medium voltage overhead lines, which necessarily involve small cross sectional areas. Increased strength and safety against fracture are secured by steel wire reinforcements. Pioneer work in Canada and U. S. A. is reviewed and the new proposals for German standards are tabulated. A diagram compares ultimate load and maximum suspension length of Cu and Al-steel cables referring to cross sections of equal electric conductivity. Al-steel cables withstand a breaking load 40% larger than Cu ones. With small cross sections Cu permits larger suspensions but the combination Al-steel gains rapidly at higher diameters. A second diagram proves the greater safety of Al-steel cables against failure due to ice loads at —5° C. A comparison between 2 electrically equivalent cables shows:

	Cu	Al-steel
Actual cross section in mm.²	25	50
Cable diameter in mm.	6.5	9.6
Cable weight in kg./m.	0.223	0.2
Suspension in m.	60	60
Sagging at +40° C. in m.	.73	.54
Sagging at —5° C. + additional load, in m.	.77	.60
Ultimate load in kg.	968	1690
Safety factor at —5° C. + additional load	8.3	13.4

WH (14)

Metals and Alloys in Dentistry. OSCAR E. HARDER. *Metals & Alloys*, Vol. 5, Nov. 1934, pages 236-241. Describes the several types of metals and alloys used in dental restorations and developments in new materials for this work. WLC (14)

Special Metals in Oil Field Practice. P. H. BRACE. *Metals & Alloys*, Vol. 5, Sept. 1934, pages 181-183. Discusses the peculiar magnetic and corrosion resistant properties of metals used in prospecting, surveying instruments and operating equipment used in oil well work and the handling and refining of crude oil. Tool materials for drilling and casing tubing properties are described. WLC (14)

How to Counteract the Shortcomings of Material in Processing Worm Gears (Wie begegnet man der Materialknappheit bei der Herstellung von Schneckenrädern und dergleichen?) *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Oct. 14, 1934, pages 430-432. Discusses the excellent properties of worm gears, cogs, made of red brass, body of cast Fe or steel and outlines the practice applied by a German foundry. Composition of cog material 86% Cu, 11% Sn, 1% Zn, 2% Pb. Proper pretreating of worm gear body is stressed to avoid cracking of cog ring. GN (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Bearing Metals. Lubrication still Faces Engineers. *Machine Design*, Vol. 6, July 1934, pages 28-29. Discusses experiments of Sparrow who found that the following babbitts were utilized with varying results in automobile engines but no definite superiority can be claimed for any one of the alloys:

	I	II	III
Cu	2.5	3.7	4.5
Sb	8	7.3	4.5
Sn	89.5	89	91

A babbitt thickness of less than .03" has been found undesirable. Cu-Pb alloys are superseding babbitt for main and connecting rod bearings. A typical analysis shows physical characteristics less affected by temperature, comprises 45 Pb, 2 Ni, balance Cu. WH (14a)

Federal-Mogul Tests Efficacy of Copper Alloy Cylinder Heads. *Automotive Industries*, Vol. 71, Oct. 20, 1934, pages 474-475. As a result of tests conducted at Battelle Memorial Institute under a joint sponsorship by Federal-Mogul Corp. and Calumet and Hecla Cons. Copper Co., supplemented by road tests and motor boat engine tests, it has been shown that with copper alloy cylinder heads higher compression ratios are practical than with cast iron or aluminum heads. Such ratio increases result in increased power output and improved fuel economy. Fuel consumption was found to be somewhat less with the copper head even at the same compression ratio. It is believed that the higher heat conductivity of the copper head tends to eliminate local hot spots. Total carbon accumulation after comparable 100 hour runs was about 3 times as much for cast iron and twice as much for aluminum as for copper cylinder heads. As an indication of results attained, 22 miles per gallon of fuel was consumed at a car speed of 35 miles per hour with a 7.5:1 ratio and copper head compared to 16 miles per gallon with an aluminium head having a 6.7:1 ratio. BWG (14a)

Collapsible Tubes. *Tin*, Sept. 1934, page 8. A brief description is given of the steps in the manufacture of collapsible tubes. Refined Sn is melted with 0.5% Cu, cast into 16" x 4" x 5/8" slabs, rolled to proper thickness and slugs punched from these metal strips. After coating the slugs with a thin oil film by tumbling, they are extruded at the rate of 44 per minute, blown free from the dies by air blasts and automatically trimmed, threaded and capped. BWG (14a)

Working Aircraft Sheet Metal. JOHN ENGEL. *Western Flying*, Vol. 14, Aug. 1934, page 17-18. A table shows the different thicknesses of Al sheet to be used for various parts of aircraft and suggestions are given for manufacturing and assembling. Ha (14a)

Aluminum Chairs (L'Aluminium dans la construction des sieges). J. DOUCHEMENT. *Revue de l'Aluminium et de ses applications*. Mar.-Apr. 1934, pages 2375-2384. Fully illustrated description of the best designs of chairs and seats for the contest organized by the International Bureau for the Applications of Aluminium. AH (14a)

Heat Insulation Properties of Aluminium and Applications Pertaining to Such (Les propriétés thermiques de l'aluminium et leurs applications). A. DE BIRAN. *Revue de l'Aluminium et de ses Applications*. No. 59, Jan.-Feb. 1934, pages 2311-2332. Aluminium sheet (0.007 mm., 18 g./mm.²) is a good thermal insulator (Alfol process). Between 50° C. and 200° C. for equal weight aluminium sheet is 150 times better than Kieselguhr and 30 times better than cork. It is light, easy to set up, resistant to fire, humidity, and vibrations. Aluminium is a good heat conductor and is used extensively where economical heat conduction is needed such as in heat recuperators, radiators, furnaces etc. Numerous applications described. Bibliography. AH (14a)

German Silvers (Les Maillechorts). J. COURNOT & F. HILTBOLD. *Revue du Nickel*, Vol. 5, Jan. 1934, pages 16-33. Extensive information on these alloys. Part I. Preparation. Methods of casting. For best properties and economical forming the alloys should be thoroughly homogenized before rolling. Electrolytic pickling gives best results. Alloys for wire drawing must have some β solid solution a typical composition being Cu 54, Ni 8, Zn 38. Part II. Properties such as color and composition, corrosion resistance, electrical resistance. The density is given by d = 7.695 x 0.006 (3 Ni + 2 Cu) where Ni and Cu are weight %. Mechanical properties are improved by cold working followed by annealing. Part III. Applications to industry, jewelry, decorating art. Description of three machines used for bend tests. AH (14a)

Nickel alloys for Machinery (Les alliages de Nickel dans l'outillage). *Revue du Nickel*, Vol. 5, Apr. 1934, pages 71-102. Very extensive, comprehensive, and illustrated review on the use of nickel for machinery. Data, curves, composition, heat-treatments, properties of steels for heavy constructions, tool steels, casting alloys, cast irons, pure nickel and other special alloys are discussed in detail. AH (14a)

Suitability of Alloy Skeletons as Catalysts for Benzene Synthesis I (Über die Eignung von Legierungs-Skeletten als Katalysatoren für die Benzinsynthese I). FRANZ FISCHER & KARL MEYER. *Brennstoff Chemie*, Vol. 15, Mar. 1, 1934, pages 84-93. Based on an invention of M. Raney, highly active catalyzers are prepared by melting alloys of Ni (Co) with Si or Al or both and dissolving the latter by chemical reagents. Efficiency tests showed that vacuum melting in a high-frequency furnace could be replaced by melting in air. EF (14a)

All-Welded Light-Weight C. M. St. P. & P. Coach. *Railway Mechanical Engineer*, Vol. 108, Oct. 1934, pages 361-365. Details of all-welded body construction and Al-foil heat-insulation are described. Total weight of car is 96,000 lbs. against 146,000 lbs. of the same coach in steel. Ha (14a)

The Application of Die Casting in the Fabrication of Electric Motors. *Machinery*, London, Vol. 44, June 28, 1934, pages 377-379. The rotors of electric motors of the short-circuited rotor type were made by one of two methods. In the first the Cu parts were joined by means of riveting, soldering, and welding, giving a rotor of relatively high weight. In the second method efforts have been made to use a light metal as a substitute for Cu, fluid metal being poured into the cavities formed by the winding slots of the plate assembly. The casting process fails to meet the requirements as to uniform density and close-grained structure. A further step is the application of the centrifugal casting process. Pure Al is used to fill up the slot openings and to form the end rings and cooling blades. Because of the good heat conductivity of the Al, an excellent cooling action is obtained. The rotors are produced on a die-casting machine utilizing the principle of a cold-pressure chamber, the metal being used in a pasty condition. Die-casting process and machine are described. Kz (14a)

Benzene Synthesis at Ordinary Pressures. XXII. Suitability of Novel Alloy Catalysts (Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck. XXII. Über die Brauchbarkeit von neuartigen Leigierungs-Katalysatoren). S. TSUNEOKA. *Scientific Papers of the Institute of Physical & Chemical Research, Tokyo*, Vol. 25, Nov. 1934, pages 144-151. Pursuing previous research work. (See *Metals & Alloys*, Vol. 5, July 1934, page MA 370) a Ni-Co-Si (1 : 1 : 2) alloy was prepared and most of the Si was dissolved out with NaOH leaving a Ni-Co skeleton. WH (14a)

All-Aluminum Pullmans in the United States (Ganzaluminium-Personenwagen in den Vereinigten Staaten). FR. WITTE. *Organ für die Fortschritte im Eisenbahnwesen*, Vol. 89, Aug. 1, 1934, pages 291-294. The European trend in Pullman design is to save weight by fully utilizing high-grade steel and welding, whereas utilization of light metal alloys has been translated into actual service in the U. S. Structural details of 2 American constructions are discussed fully and shown in 5 illustrations. 2 tables present data on weight of steel vs. light alloy members, 7 more important physical properties and chemical analyses of 12 Al alloys employed. The total weight reduction due to the adoption of Al alloys amounts to 50% as compared with the former all-steel Pullman, although new improvements and a greater luxury are incorporated in the new all-Al design. WH (14a)

The Use of Aluminum in the Petroleum Industry (L'impiego dell' alluminio nell'industria del petrolio.) C. SCALVEDI. *Alluminio*, Vol. 3, May-June 1934, pages 125-128. Because of its high resistance to the corrosive action of H_2S at temperatures below 120° C., Al has been used successfully to line storage tanks. It is also used as Al paint to protect the outside against the weather. AWC (14a)

Technical Uses, Surface Protection, Soldering and Welding of Aluminum (Technische Verwendung, Oberflächenschutz, Löten und Schweissen von Aluminium). H. RUDERER. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 158-162. A general discussion of fields of application and advantages, processes for protecting the surface, and cutting and joining by different welding methods. Ha (14a)

Modern Light Metal Pistons (Neuzeitliche Leichtmetallkolben). M. v. SCHWARZ. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 148-157. Material and design of pistons made in ever increasing degree of light metals are discussed and results of operation and advantages obtained compared with cast Fe pistons. 3 groups of Al piston alloys are considered, (1) with high Cu content, (2) with high Si content, and (3) with high Mg content; the latter are used only for racing cars due to their short life. The properties of the most used alloys are given in a table, and best method of manufacture is described. Ha (14a) 1

Importance of Nickel from the Point of View of Food Hygiene in the Literature (Die Beurteilung des Nickels vom lebensmittel hygienischen Standpunkte nach dem Schrifttum). W. SCHREIBER. *Korrosion & Metallschutz*, Vol. 10, Sept. 1934, pages 205-212; Oct. 1934, 229-235. A comprehensive review of literature dealing with behavior of Ni when used as material for utensils handling foodstuffs. Tables are given showing amount of Ni dissolved by water, liquids, vegetables, fruits, acids contained and occurring in foods; comparative figures for resistance of Cr-Ni steel, pure Ni, monel metal and German silver are given, the first behaved best against butter and milk, pure Ni worst. Rolled Ni was less attacked than cast or electrolytic Ni. The Ni contents of oils and fats, and in fruits and vegetables, in organs and bodies of animals are compiled in tables. 14 notes and 111 bibliographical references. Ha (14a) 2

Aluminum Surfaced Mirrors. H. SPENCER JONES. *Nature*, Vol. 133, Apr. 14, 1934, page 552. Description of Strong's technique for vacuum distillation of Al on telescope mirrors and of the advantages of such a coat over the usual silver layer. CSB (14a) 3

Bearing Metals of Lead Hardened with Alkali and Alkaline Earth Metals. LELAND GRANT. *Metals & Alloys*, Vol. 5, Aug. 1934, pages 161-164; Sept. 1934, pages 191-195. 32 references. High compression strength and hardness are satisfactory but load carrying capacity and action under high speeds are not so good as Sn base alloys. Low coefficient of friction and high melting point are desirable and these alloys offer a useful intermediate bearing material between Sn and Pb base alloys. WLC (14a) 4

Aluminum in the Chemical Industry. FRANCIS C. FRARY. *Industrial & Engineering Chemistry*, Vol. 26, Dec. 1934, pages 1231-1237. The advantages of Al as a material of construction for the chemical industry center around its high resistance to corrosion by many substances, the colorless nontoxic character of its corrosion products and their inability to catalyze oxidation or other changes, and the combination of its lightness, strength, and high thermal and electrical conductivity. The chief disadvantage of Al as a construction material is its sensitiveness to alkalies, halogens, and halogen acids. Corrosion with certain agents may be inhibited, and the presence of traces of heavy metals will cause acceleration of corrosion. Wrought and cast units can be fabricated to satisfy a large variety of industrial needs with due consideration to the temperature limitations of Al. MEH (14a) 5

Increased Load-Capacity of a Rope Railway (Aumento della capacita sulla funivia Oropa-Lago Mucrone. Erhöhung der Transportfähigkeit der Seilschwebebahn Oropa-Lago Mucrone). U. CARLEVARO & AD. M. HUG. *L'allégement dans les transports*, Vol. 3, May/June 1934, pages 55-59; July/Aug. 1934, pages 89-94. Claims unique pay load capacity of 23.8 kg./passenger as compared with 37 — 112 kg./capita with other rope railways due to a far-reaching adoption of light metal alloys. The following data on Avional D utilized are given: Spec. weight = 2.76, ultimate strength = 40 kg./mm.², limit of elasticity = 25 kg./mm.² modulus of elasticity = 7200 kg./mm.², Brinell hardness = 100 kg./mm.² and elongation = 18-24%. The low modulus of elasticity is not considered as a drawback (1/3 of steel). The ability of absorbing concentrated stresses under elastic deformations is pointed out. Special precautions were observed such as low cutting speeds and application of turpentine on machining, storing of quenched rivets in dry ice boxes in order to avoid losses of strength of the age-hardened alloy. Direct contacts with Cu and its alloys were avoided to preclude danger of electrolytic corrosion. Avional parts in contact with steel were painted with ZnO suspended in linseed oil. Assembling, inspection, etc., are fully discussed and structural details shown in 21 illustrations. EF (14a) 6

Suitability of Aluminum for Making Cans (Die Eignung von Aluminium zur Herstellung von Konservendosen). *Die Umschau in Wissenschaft & Technik*, Vol. 38, Sept. 2, 1934, page 721. Tests by Lunde in the Norwegian Research Laboratory for Canning Industries, Stavanger, proved the usefulness of Al cans for preserving sardines, herrings, etc. However, tomato juice and salty contents resulted in hydrogen liberation and swelling up of the cans. Experiments with animals fed over a long period of time with food preserved in Al cans showed the non-poisonous character of the new can material. Lower transport expenses, absence of metallic taste, easy opening of can and possibility of utilizing empty cans as scrap material are stressed as advantages. WH (14a) 7

Utilization of Aluminum for Overhead Transmission Lines (Umstellung auf Aluminium im Freileitungsbau). *Elektrizitätswirtschaft*, Vol. 33, Sept. 15, 1934, pages 343-346. Reference is made to the tendency in Germany to replace imported Cu by "domestic" Al for transmission lines. Information is given on physical properties, chemical properties, peculiar structural features of Al overhead lines and accessory equipment, literature on utilization of Al for the special purpose discussed, specifications to be met with by Al in regard to analysis, welded joints, wire surface, testing tolerance, strength, elastic bending properties, electric conductivity, and rope breaking load. Specifications on steel wires used as reinforcement are also included referring to wire strength, elastic bending testing, and inspection of galvanized coat. WH (14a) 8

Accident with a Tank Truck (Accident avec un camion-citerne. Unfall mit einem Benzin-Tankwagen). *L'allégement dans les transports*, Vol. 3, Mar./Apr. 1934, pages 33-34. Besides the reduction of weight, an advantage of Al over steel as structural material for tank trucks is said to be due to the higher "deformation strength and greater safety in accidents." A case is reported involving a welded tank built of Al-Mn sheets. EF (14a) 9

10

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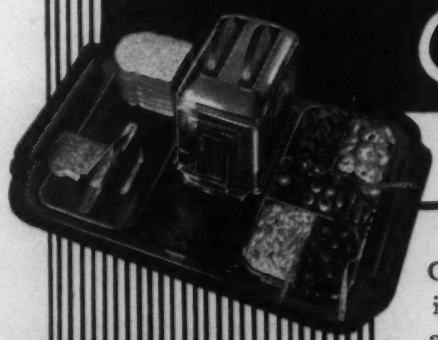

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14b. Ferrous

M. GENSAMER, SECTION EDITOR

Steels for Cracking Apparatus (Stahllegierungen für Spaltapparate). R. HARTNER-SEBERICH. *Brennstoff Chemie*, Vol. 15, Sept. 15, 1934, page 355. Contrary to the requirements to be met with by hydrogenation apparatus, the structural material utilized for cracking apparatus need not be resistant to the attack of hydrogen at high pressures, but must be corrosion resistant. Protective layers such as calorizing, electrolytic coatings, etc., are too thin and too sensitive to mechanical and thermal stresses. 18/8 low in C and containing .5% Ti is suitable but expensive. Cr steels with 4-6% Cr are rendered more resistant by adding .5% Mo or .05-.1% V. Ni does not improve the corrosion resistance. Low Cr steels however are not as immune to scaling as 18/8. By addition of .6-.8% Si or Al, a 4-5% Cr steel becomes resistant to scaling up to 600°C. Better results are obtained with Cr-Si-Al-Mo steels in which 1 part Al = 5-7 parts Cr with respect to improving resistance to oxidation. Recent tendencies in Germany are to utilize duplex material in cracking apparatus, i.e. a scale resistant shell on a corrosion resistant tube. EF (14b)

Cast Iron Tomb Stones (Gusseiserne Grabkreuze). B. OSANN. *Die Giesserei*, Vol. 21, Oct. 12, 1934, pages 435-436. Advantages of making or replacing tomb stones of wood or stone by cast Fe, especially of charcoal iron made in small charcoal cupolas, are pointed out. The greater resistance to weather is due to the eutectic structure and freedom from ferrous oxide of this Fe. 4 references. Ha (14b)

New Alloy for Springs. *Heat Treating & Forging*, Vol. 20, May 1934, pages 243-245. **Develops Improved Spring Material.** *Steel*, Vol. 94, May 14, 1934 page 41. Discussed inherent errors in springs, invention of "Invar" and "Elinvar," and properties of "Iso-Elastic," an alloy developed by John Chatillon & Sons. MS (14b)

Alloys for Springs with a Low Temperature Coefficient of Elastic Modulus (Ueber Legierungen für Federn mit kleinen Temperaturkoeffizienten des Elastizitätsmoduls). R. STRAUMANN. *Zeitschrift für Instrumentenkunde*, Vol. 54, Jan. 1934, pages 29-30. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 465. EF (14b)

Magnetically Soft Alloys (Magnetisch weiche Legierungen). B. STRAUSS, F. STÄBLEIN & H. H. MEYER. *Technische Mitteilungen Krupp*, Vol. 2, Sept. 1934, pages 98-101. Discusses the application of Krupp "Hyperm" alloys, which include both Si steel and high Ni alloy types. For high induction (saturation) use "Hyperm 6" Fe-Si steel. For high initial and maximum permeabilities high Ni (Hyperm 50Y or Hyperm 36 depending on specific resistance required) recommended, but where cost must be kept low, Hyperm 4 (2.5 to 4.5% Si steel) serves, especially in construction of precision transformers adapted to considerable overload. Hyperm 4 has a watt loss of only 0.6 to 0.7 watts/kg., 30 to 50% smaller than normal sheets. The author points out that low retentivity has little meaning in cases where even a very small air gap exists, and that low coercive force is a good measure of the suitability of magnetic materials for relays and measuring instruments. MG (14b)

Wear Resistant Castings for Chemical Apparatus (Verschleiss fester Guss im chemischen Apparatebau). ROESCH. *Brennstoff Chemie*, Vol. 15, July 15, 1934, pages 275-276. 12% Mn steel for crushing and grinding machinery owes its wear resistant properties to a slip interference phenomenon in the solid solution due to cold working while tensile strength and yield point are comparatively low. Consequently difficulties in machining of 12% Mn steel are encountered. If shocks are absent, white cast Fe, which owes its wear resistance to the presence of Fe carbide, is suitable. Members exclusively exposed to grinding effects may be only case-hardened. Wear in pumps is counteracted by heat treated Cr alloys involving a high percentage of Cr carbides. Notable corrosion and erosion resistance (pumps) distinguishes Si-bearing cast steel which however is relatively brittle and difficult to machine. EF (14b)

Iron Rolls in Paper Industry (Die eisernen Walzen in der Papierindustrie). E. SCHARFFENBERG. *Zellstoff & Papier*, Vol. 14, June 1934, pages 238-240. By means of 6 microstructures the special properties of and requirements for (cast) Fe rolls utilized in paper industry are discussed and the fabrication of these rolls is outlined. EF (14b)

Metal Heat Insulation. JOSEPH LEGRAND. *Refrigerating Engineering*, Vol. 27, Feb. 1934, pages 78-79, 81, 94. Fundamentals of heat insulation are reviewed and the application of steel for that purpose discussed. VVK (14b)

Trends in Development of Steel Houses in United States. FRANK MAIN. *Steel*, Vol. 95, July 9, 1934, pages 23-25. From paper read before Third International Congress for Steel Development, London, Eng., June 20-23, 1934. Pays special attention to steel-frame houses and describes various systems of nailing collateral materials to steel. MS (14b)

A Comparison of Cold-headed and Machined Screws. P. MABB. *Machinery*, London, Vol. 44, May 31, 1934, pages 247-250. Troubles arise frequently due to screw breakage and the work detailed in the article was undertaken to ascertain the behaviour of screws made from different steels under service conditions outlined. Kz (14b)

Use Governs Choice of Gear Steel. *Machine Design*, Vol. 6, June 1934, pages 33-34. Summarizes a paper by T. R. Rideout before the Annual Meeting of the American Gear Manufacturers' Association. See "Steels for Heat-treated Gearing," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 416. WH (14b)

Steels for the Chemical Industry (Stähle für die chemische Industrie). F. HENGLER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Oct. 6, 1934, pages 1163-1167. Steels used in the chemical industries must possess resistance against acids, lyes, solutions and gases, mechanical properties being of secondary importance. Cr and Cr-Ni steels, with additions of Mo, Cu and Si, are most used materials; the different ferritic-pearlitic, martensitic and semi-ferritic Cr steels and austenitic Cr-Ni steels and their particular fields of application and properties are reviewed and described briefly. Ha (14b)

Some New Developments in the Field of Special Steels (Einige neuere Entwicklungen auf dem Gebiet der Sonderstahle). A. FRY. *Technische Mitteilungen Krupp*, Vol. 2, Sept. 1934, pages 92-98. The author discusses briefly the composition and properties of the new structural steels St 48 and St 52, non-aging steel (Izett), high temperature boiler steels, hydrogen-resistant steels, semi-stainless and stainless steels, heat-resistant steels, steels for nitriding, and electrical steels. Briefly mentions methods successful in guarding against fatigue failures (nitriding, pre-stressing), and improvements in welding. MG (14b)

Road Pavement Protected by Cast Iron Grates of Polygonal Shape (Mit gusseisernen Polygonrosten bewehrte Strassendecke). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Sept. 2, 1934, page 567. Describes the polygonal cast Fe grate, system Brandenburger. Building and maintenance of roads paved with such grates are cheaper and superior to other methods. GN (14b)

New Radio Tower Uses 132 Tons of Structural Steel. *Steel*, Vol. 95, July 2, 1934, page 34. Describes vertical radiator antenna of station WLW. MS (14b) VSP (14b)

Nickel-Iron Alloys in I. C. Engine Construction. *Engineer*, Vol. 157, Apr. 13, 1934, page 379. Possibilities of using alloys containing approximately 36% Ni in internal combustion engines. The use of Ni cast irons is also dealt with. LFM (14b)

1 **Manufacture of Valves.** C. A. ALISON. *Heat Treating & Forging*, Vol. 20, June 1934, pages 296-297. From *Australian Engineer*. Paper read before the Steel Treatment Research Society, Australia. Outlines method of forging valves. Materials most commonly used in Australia are the 3% Ni, silchrome, and sometimes the austenitic steels. MS (14b)

— **Steel as the Construction Material of the Future (Der Stahl als Werkstoff der Zukunft).** KRUPP VON BOHLEN UND HALBACH. *Montanistische Rundschau*, (Section *Stahlbau-Technik*). Vol. 26, Oct. 16, 1934, pages 7-8. A review of the results attained in modifying the physical and chemical properties of steel through proper alloying agents and through heat-treatment. Development of welding has greatly increased the usefulness of steel. Cites uses in construction, chemical industries, transportation, high-pressure technique. Greater precision in testing methods has made possible a much better factor of safety in construction. Use of rustless steels in the construction of dwellings appears to be a definite possibility. BHS (14b)

2

— **Properties and Applications of a Special High Nickel Steel for Construction Purposes (Propriétés et applications d'un acier spécial de construction riche en nickel).** M. ROBERT GAILLARD. *Revue du Nickel*, Vol. 5, No. 2, April 1934, pages 103-107. The nickel steel "NY" has the following composition: C 0.07-0.20, Mn 0.35, Ni 4-7. When quenched from 825° C. and drawn to 610° C or cooled slowly from 825° C. it has the following properties: Elastic limit 40 to 60 kg./mm.², tensile strength 55 to 65 kg./mm.², elongation 25 to 18%. When quenched from 825° it has: elastic limit 100 ± 10 kg./mm.², tensile strength 120 ± 10 kg./mm.² Elongation 8%. AH (14b)

3

— **Selection of Steels for Plant Applications.** FRANK J. ALLEN. *Iron Age*, Vol. 133, May 10, 1934, pages 21-24, 74. See "Steels in General Shop Practice," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 542. VSP (14b)

Improving Performance and Economy of Cast Iron. C. M. LOEB, JR. *Steel*, Vol. 95, July 2, 1934, pages 26-28. Paper read before Connecticut Foundrymen's Association, June 15, 1934. Discusses effect and uses of Mo in cast-Fe. See "Molybdenum as an Aid in the Iron Foundry," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 494. MS (14b)

4

— **The Manufacture of Drill and Other High-Grade Steels at Vereeniging, Transvaal.** J. H. DOBSON, G. ROBSON, J. BURNARD BULLOCK & H. CLARKE. *Journal of the Chemical, Metallurgical and Mining Society of South Africa*, Vol. 35, Aug. 1934, pages 42-43. Discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 300. AHE (14b)

5 **Steel Progress and the Cement Manufacturer.** A. C. ROWE. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, Sept.-Oct. 1934, pages 295-297. Steels suitable for use in the mining and cement industry are discussed. AHE (14b)

— **Stabilized Stainless Steel and its Applications in the Pulp and Paper Industry.** C. S. CONRAD & M. H. FREEDMAN. *Paper Trade Journal*, Vol. 99, July 26, 1934, pages 33-35. 18-8 or 25-12 Cr-Ni steels with Ti present to prevent intercrystalline corrosion have numerous uses in the paper and pulp industry. Plied metal, whereby a stabilized stainless steel surface is bonded to a mild steel, is a recent development. CBJ (14b)

6

Finish Stellite Seats for White Motors. FRED B. JACOBS. *Iron Age*, Vol. 133, May 10, 1934, pages 14-16. Describes making and machining stellite seats at the plant of the White Motor Co., Cleveland. Used for truck and bus motors. VSP (14b)

— **New Type of Steel Barrel and Features of Its Manufacture.** F. L. PRENTISS. *Iron Age*, Vol. 133, Feb. 22, 1934, pages 18-20, 68. Describes two unusual designs of beer barrels made by Midland Steel Products Co., Cleveland. The barrels are made in both the single shell and insulated double shell types. They differ in some of their essential features of design, fabrication and assembling from any others that are being made. Single shelled barrels are made of S.A.E. 1025 steel sheets, the shells 14-gage and the heads 13-gage material. The inner barrel heads are similar to single wall heads except that they have an added flange at right angles to side wall. Electric welding forms large part in manufacturing process, with butt, flash and seam welding included. VSP (14b)

7

— **Is it Possible to Decrease Maintenance Cost of Locomotives? (Peut-on Diminuer, dans une Large Mesure, les Frais d'Entretien des Locomotives?).** J. OUDET. *Science et Industrie (Métaux et Machines)*, Vol. 18, Oct. 1934, pages 283-286. Several sections deal with metals used in locomotive construction: (1) Fireboxes: it is pointed out that in firebox plates made of Ni steel are less liable to crack.. (2) Cross stays: steel costing 1.5 fr. per Kg. would give as good results as Cu-Ni alloys costing 15 fr. per kg. (3) Case-hardening of wearing parts: when steel of 50 kg./mm.² strength was substituted case-hardening was no longer used due to brittleness after treatment. It would be advisable to use a case-hardened part made of steel of 40 kg./mm.² strength. Nitrogen hardened parts must be used with caution because they are liable to peel in some cases. FR (14b)

8

— **Heat Expansion of Corrosion and Heat Resistant Cast Irons, and Material for Strut Fittings (över värmeutvidningen vid korrosions och värmebeständiga gjutjärnssorter, samt material for s.k. holmstag-fästen).** JOH. HÄRDEN. *Teknisk Tidskrift*, Vol. 64, Sept. 8, 1934 (Section *Bergsvetenskap*) pages 71-72. A Ni-Cr steel with 1.25-1.50% Ni and 0.4-0.6% Cr, produced in electric furnace is finding application for thin-walled strut fittings. Fine grain structure and high tensile strength and impact resistance permit important savings in weight with increasing safety. Contains also excerpts of articles on nickel cast irons, from *Nickel-Berichte*, Vol. 7, 1934, and Nickel Cast Iron News, Sept. 1933, page 7. BHS (14b)

9

10 **Stainless Steel Commends Itself to the Railroads.** T. H. GERKEN. *Iron Age*, Vol. 134, Aug. 9, 1934, pages 8-13. Discusses the ues of stainless steel in the construction of railroad rolling stock. Special consideration is given the Zephyr built for the Chicago, Burlington and Quincy Railroad by the Edward G. Budd Co.

15. GENERAL

RICHARD KIMBACH, SECTION EDITOR

The International Foundry Conference in Czecho-Slovakia. T. MAKEMSON. *Foundry Trade Journal*, Vol. 49, Oct. 19, 1933, pages 217-220; Oct. 26, 1933, pages 234-236. A description of the above conference, accompanied by detailed considerations of visits made to the following works in Czecho-Slovakia: Ceskomoravska-Kolben-Danek, Ltd.; The Vitkovice Works; Bata Shoe Factories; Uxa Bros., Brno; Skoda Works, Pilsen Brewery. The article is illustrated by 10 figures. OWE (15)

The Curse of the Empties. H. GORDON MACKELCAN. *Chemical Industries*, Vol. 35, Sept. 1934, pages 215-216. A discussion of the cost and nuisance of having to handle empty metal and glass containers of liquid chemicals. The high investment in and cost of handling empty containers leaves a fair margin for the development of new types of cheap, strong, non-returnable packages. BWG (15)

New Subjects for Today's Research. HARRY MCGOWAN. *Chemical Industries*, Vol. 35, Sept. 1934, pages 222-224. Possible improvements in building materials and construction, ventilation, accident prevention, speed of transportation, cookery and in the biological industries are discussed with suggestions on financing research. Regarding the metallurgical industries, money spent on research is thought to be disproportionately small for the value of the industry. Future intensive research, it is expected, will not compel us to have factors of safety for metals of four or five-fold as we must often use at present. BWG (15)

Research—Trends and Problems. JOHN JOHNSTON. *Steel*, Vol. 94, May 14, 1934, pages 44, 46. Abstract of paper read before the Pennsylvania interchapter meeting of the American Society for Metals in State College, Pa., May 4-5, 1934. Discusses a number of research problems confronting steel makers. Points out that qualities of steel do not depend upon method of manufacture but upon how method is carried out and the care used. Prefers Bessemer principle to that of the open-hearth because of the more thorough agitation of the molten metal. Advises concerted study of the method to develop it further. A current investigation is the production of Cr steel directly in the open-hearth furnace by oxidizing at high temperature with the result that C oxidizes first. Sees no merit in the low-temperature reduction of Fe ores under present conditions in the eastern part of the U. S. Since the limit to decrease in cost by mechanization has been reached, only way steel maker can improve economy for his customers is to improve quality of his steel. Ordinary chemistry of steel has been overemphasized. More attention is being paid to structure, grain size, hardenability, and similar characteristics. MS (15)

"For to Catch a Whale." JOHN HOWE HALL. *Metals & Alloys*, Vol. 5, Oct. 1934, pages 221-223. Describes history of a research which began with purpose of producing a steel suitable for making large and heavier Mn steel casting and resulted in production of welding rod of that material. WLC (15)

New High-Frequency Electric Steel-Melting Plant. *Mechanical World & Engineering Record*, Vol. 95, Apr. 20, 1934, pages 383-385. Technical features and capabilities of the automatically controlled plant of the United Steel Co. Ltd., are discussed by means of drawings and photographs. Kz (15)

The National Physical Laboratory. *Engineering*, Vol. 138, July 13, 1934, pages 27-29; Aug. 3, 1934, pages 108-110; Aug. 10, 1934, pages 149-152. Review of investigations as summarized in the Laboratory's report for 1933. Includes sections on fatigue and corrosion-fatigue, hardness, ductility, and creep testing, an experimental and mathematical study of the strength of thin panels of sheet metal, preparation of pure iron, properties of molten metals, gases and oxides in iron and steel, Cu and light alloys, and on materials for use at high temperatures. LFM (15)

Non-Ferrous Metals Research. *Engineering*, Vol. 138, Aug. 17, 1934, page 180. Brief summary of investigations as outlined in the annual report for 1933 of the British Non-Ferrous Metals Research Association. LFM (15)

We Survey the Results of Engineering Activity. *Product Engineering*, Vol. 5, Nov. 1934, pages 403-423. A comprehensive review and statistics of engineering materials, light metals, mechanical properties and composition of alloy steels and fields of applications, processes and finishes. The influence on design by the new materials is pointed out. Ha (15)

The Electronic Structure and Properties of Matter. C. H. DOUGLAS CLARK. John Wiley & Sons, Inc., New York, 1934. Cloth, 5¾ x 8¾ inches, 373 pages. Price $5.50.

The title page carries the sub-title "An Introductory Study of certain Properties of Matter in the Light of Atomic Numbers Being Volume 1 of A Comprehensive Treatise of Atomic and Molecular Structure." Two other volumes have apparently been written as this volume contains references to them by section and sub-section.

"The present volume is the result of an attempt to summarize the explanations which have been advanced in connection with certain properties of matter in terms of electronic constitution."

There has long been the hope that the electronic structure of an element could be predicted from its atomic number, and that given its electronic structure other properties could be predicted. The author shows that the electronic structure of the elements is, to a great measure, known, and that the periodic classification and the atomic spectra can be explained. Other properties are not as satisfactorily handled, though several remarkable conclusions of limited applicability can be drawn.

Very few properties of specific interest to metallurgy are treated. Portions of the discussion of atomic radii, electrical conductivity and magnetism are of interest in theoretical metallography. There is scant mention of metals in the chapter dealing with cohesive forces.

Those who wish to get modern atomic theory as a connected non-mathematical story will find the book of value. Little new and original is given, but the bibliography of the original sources is excellent. H. W. Russell (15) -B-

Handbook of Inorganic Chemistry (Handbuch der anorganischen Chemie). R. ABEGG, F. AUERBACH & I. KOPPEL. Vol. 4, Section 3, Part B, Division 2, No. 3. S. Hirzel Verlag, Leipzig, 1935. Paper, 7 x 10 inches, pages B 675-B875. Price 28 RM.

This section of Abegg's handbook deals with catalysis by iron and its compounds and with the colloid chemistry of iron compounds, thus containing little of direct application to metallurgy. Twenty pages are devoted to brief mention of analytical methods for the elements usually determined in iron and in alloy steels, with selected references. H. W. Gillett (15)-B-

Relation of Research to the Establishment of Electrometallurgical Industries in the State of Washington. The Development of a Magnesium Industry. CARL F. FLOE. *State College of Washington, School of Mines & Geology, Metallurgical Research Bureau, Information Circular* No. 9, Aug. 1, 1934, 5 pages. General. AHE (15)

Recent Progress in Electro-Metallurgical and Electro-chemical Industries (Les Recents progrès des Industries Electrométallurgiques et Electrochimiques). A. CLERGEOT. *La Technique Moderne*, Vol. 26, June 1st, 1934, pages 373-378. Applications of electricity are briefly described in the following industries: (1) Electrolysis of molten substances. (a) Al, (b) Mg, (c) Other metals: Be, Li, Na, Ba, Ca, V. (2) Electrolytic refining of metals (a) Cu, (b) Ag, (c) Au, (d) Pb, (e) Zn, (f) Ce, (g) Sn. Last section of the article is devoted to Cr plating in cold baths. FR (15)

2 **Metallurgical Research Should Suit Type of Research to Problem.** O. W. ELLIS. *Metals & Alloys*, Vol. 5, Aug. 1934, pages 165-166 & 175. Discusses research methods and workers. WLC (15)

Outlook for Profitable Research in the Metallurgy of Copper. R. S. DEAN & F. S. WARTMAN. *Progress Reports—Metallurgical Division. 3. Studies in the Metallurgy of Copper. United States Bureau of Mines, Report of Investigations* No. 3228, May, 1934. pages 3-13. There are opportunities for profitable research in (1) developing new uses for Cu, (2) leaching wastes from some mechanical treatment process, (3) more complete elimination of undesirable gangue from concentrates, (4) development of more efficient grinding methods, (5) improvements in methods of Cu smelting, (conservation of heat, improvement of refractories and reduction of losses in slag), (6) development of new methods of producing Cu from its concentrates, (direct leaching of concentrates (involving development of suitable solvents), roasting followed by a regular H_2SO_4 leach, and combination smelting), and (7) recovery of by products (Fe, S, etc.) AHE (15)

3

When Should Welded Structures Replace Castings? J. L. BROWN. *Machinery*, N. Y., Vol. 41, Sept. 1934, pages 13-16. Conditions and factors important in deciding whether a casting or welded structure is more advantageous for a given purpose are discussed. Ha (15)

Conversazione of the Institution of Civil Engineers. *Engineer*, Vol. 157, June 22, 1934, pages 634-636; *Engineering*, Vol. 137, June 22, 1934, pages 710-712. Describes exhibits at meeting held June 13, 1934. Frederic Bacon showed photographic studies of cracking and fracture caused by fatigue and corrosion. Sir Robert Hadfield's metallurgical exhibit included the development of modern cutting tools, illustration of a method for determining the internal stresses in the head of a rail, the changes in the diamond pryamid hardness scale from lead to tungsten carbide and an illustration of the practical problems solved by the use of heat-resisting and corrosion-resisting steel. Sherard Cowper-Coles showed steel girders and rails coated with electrolytically-deposited lead in order to protect them from sulphurous fumes and other corrosive conditions. LFM (15)

4

5 **Statistical Method in the Foundry.** K. NEUSTÄTTER. *Foundry Trade Journal*, Vol. 50. Mar. 22, 1934, page 203. See "Application of Statistical Methods in Practical Cupola Furnace Operation," *Metals & Alloys*, Vol. 5, July 1934, page MA 372. OWE (15)

What Price Beauty of Line and Color. O. KUHLER. *Metal Progress*, Vol. 26, Aug. 1934, pages 23-25 & 56. Discussion of the trend toward beauty of line and color in locomotives, buildings, packages and all sorts of containers whether of metal or other materials. WLC (15)

Canadian Copper from the Mine to the Wire User. D. HORSFALL. *Wire & Wire Products*, Vol. 9, Sept. 1934, pages 316-320, 353. History and development of Canadian Cu industry, description of electrolytic refining methods in Canadian practice and wire drawing processes are described. Ha (15)

6

International List of Electrochemical and Electrometallurgical Firms (Répertoire International des Sociétés Électrochimiques et Électrométallurgiques). R. PITAVAL & R. SEVIN. Société des Publications Minières et Métallurgiques, Paris, 1934. Cloth, 6½ x 9½ inches, 206 pages.

The preface contains a few general statistics on electric furnace projects and some regulations on shipment of calcium carbide and ferrosilicon. Then follow, by countries, lists of the firms making various electrochemical and electrothermic products, with their capacity and whether water power or coal is used. In some cases the number, type, and power rating of the furnaces or cells used are given. While the aim is to make the list complete, it is far from being so, especially in regard to the U. S. It is stated that, since some 600 electric steel furnaces and 600 for non-ferrous metals are installed in the U. S., the editors realize that their list is far from complete, but that they would be glad to include in the next edition information on the firms that will forward data on what they produce and what their furnace installation is.

Even in its present incomplete form the list is useful. H. W. Gillett (15) —B—

7

What to Do about your Invention. E. THOMAS. Leisure League of America, New York, 1934. Paper, 5½ x 8 inches, 109 pages. Price 25c. A rather readable discussion of the usual topics treated in books about patents, and like most such books, featuring the idea that "millions" are returnable from some patents, and stressing the complexity of the patent game and the importance of using a good patent lawyer. One interesting feature is the emphasis placed on drawing claims so that they read clearly, without undue legal verbiage, this being said to deter infringement. The pamphlet is cheap and will serve as well for an introduction to the subject as most of the more expensive treatises.

H. W. Gillett (15) —B—

8

9 **The Iron and Steel Industry.** CLYDE E. WILLIAMS. *Mining & Metallurgy*, Vol. 15, Jan. 1934, pages 31-36, 45. Important progress in all branches of Fe and steel metallurgy has been made during 1933. Research work has been intensive and plant application of research developments has been rapid. Increasing recognition was given to commercial possibilities of using precipitation-hardening in alloy steels and progress made in aging phenomena. Following topics relative to Fe and steel industry are discussed: Iron ore and smelting by T. L. Joseph; Steel-making progress by C. H. Herty, Jr.; Alloy steels by Jerome Strauss; Cast iron by J. T. MacKenzie; and Steel foundry practice by R. A. Bull. VSP (15)

10 **The Application of Statistical Methods to Production and Research in Industry.** R. H. PICKARD. *Glass*, Vol. 11, Nov. 1934, pages 435-438, 446. The practical advantages to be derived from applying statistical methods to industrial processes, in determining quality of mass products, for setting down rules for specifications, in problems of management and research, etc., are pointed out and exemplified. Ha (15)

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15a. Economic

A Chemical Engineer Views the Steel Industry. CHARLES F. RAMSEYER. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 582, *Metals Technology*, Oct. 1934, 13 pages. Operation of the basic processes of steel making has not changed significantly in either theory or fundamental design of equipment in the past 75 years. Lack of development in steel making is attributed to policy of management and to the enormous expense of large-scale high-temperature metallurgical development work. It is claimed that for every $100,000 spent on the trial of chemical processes on a semi-commercial scale a million dollars might easily be required in the high-temperature field. Batch production is considered as archaic, and continuous counter-flow methods of steel production are visualized. A suggested plant is estimated to produce steel at a cost of $5 per ton less than the present cost. Development of this plant might require an expenditure of $5,000,000 a year for a period of 10 years, but this would lead to an annual saving of $150,000,000, or 300% on the investment. JLG (15a)

The Progress and Outline of the Work of the Technical Committee. L. S. MARSH. *Preprint American Iron and Steel Institute*, May, 1934 meeting, 10 pages; *Blast Furnace & Steel Plant*, Vol. 22, June 1934, pages 328-332; *Steel*. Vol. 94, May 28, 1934, pages 30, 32, 34, 42; *Iron Age*. Vol. 133, May 24, 1934, pages 15, 68, 70, 72; May 31, 1934, pages 30-31. The Technical Committee is engaged in a thorough study of the various sections of the book of "Uniform Extras and Deductions for Products of the Iron and Steel Industry under the Code of Fair Competition," a study of technical descriptions and classifications of products filed with the Iron and Steel Institute and coöperative work with the Commercial Committee. VVK (15a)

Statistical Compilations on Lead, Copper, Zinc and Tin. *Metallgesellschaft*, Sept. 1934, 26-30. World production and prices from 1928 to August 1934. Ha (15a)

Brazilian Iron and Steel Industry. *Iron & Coal Trades Review*, Vol. 129, Oct. 12, 1934, page 543. There exist 6 metallurgical enterprises at present in Brazil; financial conditions, output in steel castings, and other statistical data are given. Ha (15a)

Russian Iron and Steel Production. *Engineer*, Vol. 157, Apr. 20, 1934, page 412. The Soviet program for 1934 aims to produce 10 million tons of pig iron, 9,800,000 tons of steel and 6,600,000 tons of rolled products. The statistics for the first quarter of this year show that the quota will probably be met. No exports are contemplated as all the products are needed to carry out Soviet plans of development. LFM (15a)

The Steel Trade in the Melting Pot. *Engineer*, Vol. 157, Mar. 2, 1934, pages 229-230. Editorial discussing the controversy in the British iron and steel industry over the National Committee's reorganization scheme. The main objection to the scheme is that it introduces a system of quotas and makes no provision for modernizing the existing plants. LFM (15a)

The French Tinplate Industry. *Tin*, Sept. 1934, pages 18-21. This review of developments in recent years is extracted from a report dated June 1934 on "Economic Conditions in France," by Sir Robert Cahill which was issued in Aug. 1934 by the British Dept. of Overseas Trade. It describes the growth of the French tinplate industry to a 1933 capacity of from 180,000 to 200,000 long tons, the location and relative importance of the chief producers, and, in some detail, the plants and products of the largest producer, Carnaud et Basse Indre, as well as giving general information on imports, exports, consumption, customs duties, and organization of the trade. BWG (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in California in 1933, by Counties. F. W. HORTON. *United States Bureau of Mines, Mineral Market Reports*, No. M. M. S. 316, Sept. 25, 1934, 2 pages. Au output in Calif. in 1933 was 613,578.85 oz., an increase of 44,411.86 oz. over 1932. Ag declined 90,942 oz. to 402,591 oz. AHE (15a)

Scrapping of Locomotives and Railroad Cars (Verschrottung von Lokomotiven und Eisenbahnwagen). H. HERMANNS. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, July 14, 1934, pages 859-860. The question of procuring sufficient scrap metal for steel production is discussed, methods to break up railroad material economically, and practice as used by the New York Central Railroad is described. Ha (15a)

15b. Historical

The Primitive Use of Gold. T. A. RICKARD. *Bulletin of the Institution of Mining & Metallurgy*, No. 360, Sept. 1934, 28 pages. A review. 87 references. AHE (15b)

Discovery and Early History of Platinum in Russia. B. N. MENSCHUTKIN. *Journal of Chemical Education*, Vol. 11, Apr. 1934, pages 226-229. History of discoveries and developments of Pt in Russia are enumerated. GTM (15b)

5

Central African Iron Smelters (Mittelafrikanische Eisenschmelzen). ALBERT KNAFF. *Revue Technique Luxembourgeoise*, Vol. 26, May-June, 1934, pages 63-68. A few historical remarks and descriptions of primitive methods of making Fe in districts of Africa which still are remote from civilization. Iron ore of the composition Fe 67.02%, or Fe_2O_3 95.74%, Al_2O_3 0.56%, P 0.026%, SiO_2 2.3%, Ca 0.36%, traces of MgO was melted; the slag contained SiO_2 21.12%, total Fe 60.10%, S 0.24%, P 0.06%, Mn 0.02%, traces of CaO and MgP. The tensile strength of the product was 84.0 kg./mm.^{2}, elongation 7.7%; the hardness of the blade of a dagger made of this iron was 100-102 Rockwell, after filing off the surface 89-90. After annealing the hardness decreased to 70-72, but increased after quenching to 103. The structure shows a fine grain and is pearlitic, after quenching martensitic. Comparison with an iron made in 1630 in Europe showed the African iron to be of superior quality. Ha (15b)

6

Gold and Silver in 1933 (Gold und Silber 1933). JOACHIM FISCHER. *Die Metallbörse*, Vol. 24, Apr. 28, 1934, page 536; May 2, 1934, page 552. Historically reviews the developments in the Au and Ag market during 1933 and presents several tables with production data. EF (15b)

The Kuznetsk Metallurgical Works. GHITA FARBMAN. *Far Eastern Review*, Vol. 30, May 1934, pages 231-235. Deals at length with the exploitation of the Ural District and summarizes the Russian accomplishments at Kuznetsk which produced 1,593 tons pig Fe/day and 1,141 tons of steel/day during September 1933. WH (15b)

7

Pioneering Metallurgy in Detroit. C. N. DAWE. *Metal Progress*, Vol. 26, Sept. 1934, page 29. Descriptive. WLC (15b)

The Genesis of the Permanent Way. FRED BLAND. *Railway Engineer*, Vol. 55, July 1934, Supplement Jubilee Souvenir of the Permanent Way Institution, pages 6-8. Historical review of the early evolution of the iron rail in Great Britain. WH (15b)

The Steel Rail. *Railway Engineer*, Vol. 55, July 1934, pages 220-221. A survey of the development of the steel rail since its introduction nearly 80 years ago down to the present day under the following viewpoints: analysis, heat-treatment, alloys, sections, length, wear, defects. WH (15b)

8

The Work of Walter Rosenhain. J. L. HAUGHTON. *Iron & Coal Trades Review*, Vol. 129, Sept. 7, 1934, pages 330-331. Biography and appreciation of his work, in particular in metallurgy. Ha (15b)

The Story of Zinc. III. IV. H. R. HANLEY. *Journal of Chemical Education*, Vol. 11, Jan. 1934, pages 33-39; Feb. 1934, pages 111-113. A history of the electrolytic method of production is given and reasons are presented for the delay in commercial application after the process was known. Fundamental concepts as well as operating characteristics are described embracing leaching, filtration, purification, and deposition. Part IV. Includes the electrothermic distillation and also the electric smelting method of production. In the former process the roasted ore and reducing carbon are formed into briquettes. These briquettes are then subjected to reduction by heat produced by the passage of an electric current through them. Large scale condensers are necessary. The latter process (electric smelting) encompasses many operations, namely, smelting to form metal matte and slag, distillation of the zinc as an impure metallic powder, and the beneficiation of the same into commercial zinc. GTM (15b)

9

Preparation of Half a Gram of Pure Protactinium. Element 91 (Reinherstellung von einem halben Gramm Protaktinium. Element 91). GEORG GRAUE & HANS KÄDING. *Die Naturwissenschaften*, Vol. 22, June 1, 1934, pages 386-388. Describes in great detail the troublesome and first chemical preparation of protactinium and its final separation from Zr and Ta. The experimenters prepared 250 g. pure (X-rays) and 250 g. "impure" (99.5%) of the element 91. EF (15b)

10

Items of Interest

Dr. Blum to Deliver Paper in London

The Faraday Society is planning a symposium upon "The Structure of Metallic Coatings, Films, and Surfaces" in London on March 29 and 30, 1935. Among those invited to participate are Dr. William Blum and Dr. Charles Kasper of the United States Bureau of Standards, who are preparing a paper upon the structure of nickel deposits. Dr. Blum expects to present this paper in person, and also to attend meetings of the Electrodepositors Technical Society in Birmingham and London. He will spend about a month in visiting plants and research laboratories in England, France and Germany that are of interest in connection with electroplating and electrotyping.

Casting Iron on Metal Molds Without a Chill

Probably the most important metallurgical development in gray iron during 1934 is the process perfected by The United States Pipe & Foundry Company "for casting on metal molds without producing chill," says Dr. James T. MacKenzie, chief metallurgist, American Cast Iron Pipe Company, Birmingham, Ala., in *Mining and Metallurgy* for January. He also includes the further discovery of the long-time, low-temperature anneal for the strengthening of material so cast.

According to patents, this process has been described as blanketing a layer of gas between the metal and the mold, "the gas being held by a powdered material such as ferrosilicon." By this method of casting, says Dr. MacKenzie, they secure a material of about the impact resistance of the old annealed product which is again vastly improved by subsequent annealing which produces a superior phosphide formation in more or less globular form as opposed to the old cellular distribution. A large part of the phosphorus seems to be held in solution.

Index to A.S.T.M. Standards

The American Society for Testing Materials has issued an *Index to A. S. T. M. Standards and Tentative Standards,* as of Jan. 1, 1935, designed to be of service in determining whether the society has issued any specifications or test methods on particular materials or subjects in the materials field. Since the total number of A. S. T. M. standards and tentative standards is some 730, the Index is a decided convenience in this respect and also very helpful to those interested in the materials field, such as purchasing agents, engineers, architects and others, in locating any of the items in the publications where they appear. All of the A. S. T. M. specifications and tests are listed in the current Index under appropriate key words and the items under a particular subject are arranged alphabetically according to the significant word in the title, thus facilitating use of the Index. A list in numeric sequence of the serial designations is also included. Copies of this publication, aggregating 142 pages, are furnished without charge to those who send requests to the Society Headquarters, 260 S. Broad Street, Philadelphia.

Electro-Platers' Convention

The annual convention and exhibiton of the American Electro-Platers' Society will take place in Bridgeport, Conn., June 10 to 13 inclusive, at the Stratfield Hotel. The chairman of the paper committee reports that he has been able to secure several outstanding technical papers which will be interesting and educational to the craft. Interesting plant visitations are being arranged and many trips and social functions are being prepared for the ladies.

The Bridgeport Branch of the Society has decided to hold an exhibit which promises to be the most complete ever held. Arrangements have been completed to hold the exposition in the Shrine Mosque in Bridgeport where there are ample facilities for accommodating a maximum of 75 exhibitors. The exhibition has been turned over to R. T. Phipps, who has been engaged to handle this end of the convention because of his previous experience in conducting expositions along similar lines in this particular building. While the convention ends Thursday, June 13, the exposition is to be held over an extra day which will include Friday, June 14.

Lindberg Heat Treating Company, Chicago, has recently installed two of the latest type SC High Speed Muffle Atmosphere Furnaces as a part of their program of maintaining a modern Heat Treating plant.

A galvanizing kettle, claimed to be the largest in the country, is located at the Penn Galvanizing Company, 2200 E. Tioga Street, Philadelphia. This huge kettle is large enough to accommodate jobs up to the size of steel plates used by shipbuilders for hull construction. Its overall dimensions measure 32 feet, 6 inches long; 34 inches wide; and 60 inches deep. To fill it 160 tons of molten zinc are required. Before this kettle was installed a survey was made of all jobs handled since the founding of the company. From this survey it was determined that, even though the cost of installing the largest kettle would be considerable, nevertheless it would assure its customers that Penn Galvanizing Company could adequately and efficiently handle their requirements, whether large or small. Furthermore, it was often necessary to galvanize large pieces in two steps, immersing first one and then the other. This practice frequently resulted in an uneven coating.

The **Campbell, Wyant & Cannon Foundry** is increasing its electric furnace capacity. Their newest unit is the largest equipment they will have, it being a furnace of 3 tons per hr. capacity on batch cold melting practice. This size is usually operated so as to make five to six ton heats when melting from the cold in 1½ to 2 hrs. time. When operating on duplex, this size equipment is usually run with about a 10-ton bath of molten metal; the duplexing rather depends on just the exact procedure being followed but 12 to 15 tons per hr. duplexed is normally about the rate of output at which an equipment of this kind is operated. Outputs, however, considerably in excess of this figure are being maintained in furnaces of this size.

The General Refractories Co., Philadelphia, Pa., announces the appointment of Patton Clay Manufacturing Co., Syracuse N. Y., as dealer-agents in the Syracuse area. The Patton Clay Manufacturing Co. will carry a complete stock of refractories in addition to its line of building materials.

Under the title of *"A Story of Man-Made Rubber,"* the first really popular description of "DuPrene" is given in a small illustrated booklet just issued by the Rubber Chemicals Division, E. I. du Pont de Nemours & Co., Wilmington, Del.

Detroit Steel Products has contracted with Surface Combustion Corporation for Continuous Type Controlled Atmosphere Clean Hardening Furnaces.

The **Duraloy Company,** New Cumberland, W. Va., has installed a 500-lb., 3-phase Lectromelt furnace. This is their third Lectromelt.

In the interest of better service to its customers, Revere Copper and Brass., Inc., announces the opening of an office at 1511 Telephone Building, 1010 Pine Street, St. Louis, Mo. Edward A. Harbeck is St. Louis District Manager.

Carl G. de Laval has been appointed sales representative of Electro Metallurgical Sales Corporation in the Pittsburgh district, effective Feb. 1.. Since 1925 Mr. de Laval has been connected with the production department of Electro Metallurgical Co., at the Niagara Falls plant. His new offices will be in the Oliver Building, Pittsburgh.

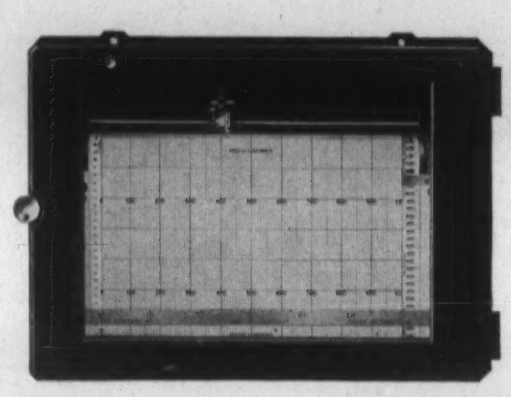
NEW EQUIPMENT & MATERIALS

A Controller-Recorder, Photoelectrically Balanced

A non-hunting, non-drifting proportional controller-recorder, photoelectrically balanced, has been brought out by The C. J. Tagliabue Mfg. Company, Brooklyn, N. Y. The new controller is designed to take care of severe cases of apparatus lag, which make control without hunting difficult. It is claimed to attain nearly the ultimate in the successful elimination of hunting. The additions to the single point recorder to accomplish nearly perfect control are simple. They are: a control-setting slidewire, a cam-operated thermocouple switch and a cam-operated control switch. As applied to a motor driven valve a single reversible motor is used. The controlling action of the instrument is easily explained. While the thermocouple is connected to the recording slide-wire, the contact-carriage follows the true temperature and records it. If the temperature increases or decreases, the control motor decreases or increases the heat supply in proportion to the change. This connection is maintained about 95% of the time, effectively counteracting drift. At intervals the potential of the control setting is substituted for the thermocouple, and the contact-carriage is brought to the correct or normal point (if it has been thrown off by a sudden change in heat supply or demand). During this brief interval the control motor is disconnected. Then the thermocouple and control motor are reconnected, the contact-carriage returns to the true temperature and the control motor corrects the heat supply in proportion to the measured departure from "normal." An outstanding feature of the instrument is pointed to as the absence of a follow-up mechanism, or any mechanical device for limiting the rate of return to normal. Also, the response to initial departures is very sensitive.

The potentiometric controller with photoelectric action is an indicating controller in which a reflected narrow beam of light from a mirror-galvanometer plays on the edge of a shield in front of a photocell. A slight deflection

of the beam from the edge gives instant response in turning on or off the power to the controlled apparatus. This is contrasted with the limitation of a pointer galvanometer with which a mechanism serves to detect deflections at relatively long intervals. For industrial purposes there is in this new controller an overabundance of available sensitivity, which has to be kept within reasonable bounds, and for laboratory purposes, it is nearly unlimited, such that the instrument must be supported free from vibrations to develop its full sensitivity, as required in control of a bath to a small fraction of a degree. This controller is a simple instrument because the only moving parts are the galvanometer and relay. A special circuit is used, so that the relay can be adjusted to close and open for as small a galvanometer deflection as the installation warrants. The photocell is, of course, not a calibrated element of the measuring circuit, and it and the amplifying tube will last years unless broken. The lamp is designed for 10,000 hours



(about 14 months) at normal voltage.

For the purpose of indicating temperature (or emf) a portion of the light beam from the galvanometer is intercepted by a 45° mirror and reflected upon a window in the door over the circular scale of the instrument. The action of the controller is readily visible at a great distance as a brilliant line of light moves to and fro in the middle of the window. The scale and slide-wire of the potentiometer are 15" long, ample length for most purposes, especially because very open scales with suppressed zero can be supplied. As an electrical measuring instrument the accuracy is 0.1%. The models available are for "on and off" two and three position controls, in single or double range for thermocouples and resistance thermometers.

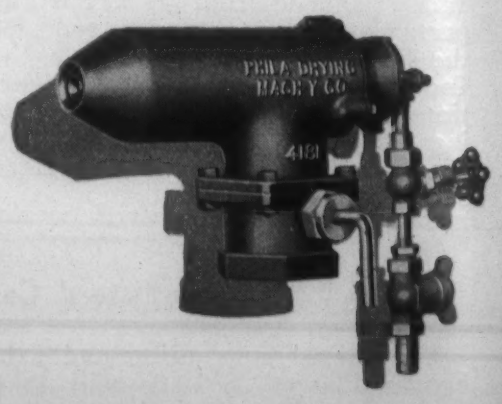
The indicating potentiometer or wheatstone bridge is a simple indicator for measuring temperatures with thermocouples or resistance thermometers. It is calibrated to 0.1% of full scale, has an accurately reproduced circular scale 15" long, and is most easily balanced and read with the bright line of light showing in the window just over the scale. The instrument is designed for use in both plant and laboratory, being rugged enough to withstand the severest plant usage, and accurate enough for a wide variety of laboratory measurements. Readings can be taken quickly because the galvanometer has a short period and ample sensitivity—the light beam is equivalent to a pointer 10" long. It can be balanced and read in the laboratory mounted on a table, by an observer either seated or standing and in the factory on a panel, it can be read in very poorly lighted places, in fact in the dark.

A Liquidizer for Castings

A carbon-free liquidizer has recently been put on the market by the Pittsburgh Metals Purifying Corp., Pittsburgh, Pa. It has been developed for replacing carbonaceous materials now used for control of shrinkage in the production of quality ingots and castings, whether gray iron, steel or nonferrous. Its purpose is to increase the yield per heat, to decrease porosity, to eliminate cavities and to increase the density. This is claimed to be accomplished through retarding the solidification of the molten metal in the head of the casting or riser, or in the ingot top. Because the new liquidizer is entirely free from carbon, it eliminates any pick-up of carbon and does not in any detail change the composition of the metal. It is also stated that when Soffel's Carbon-Free Liquidizer is used, a slow thermal reaction takes place, causing the metal to continue in the fluid state 50 per cent longer.

A New Oil Burner

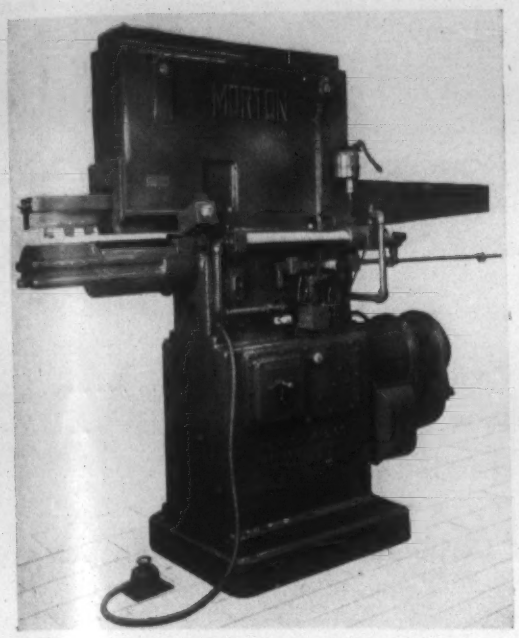
A new low pressure oil burner, developed by the Philadelphia Drying Machinery Company, Philadelphia, Pa., is designed to achieve: (1) Efficient combustion over a wide range of capacities and with various grades of fuel; (2) More uniform heat distribution throughout the furnace; (3) Close atmospheric control; (4) Freedom from dribbling and (5) Safety from explosion. It is called the "P.D.M." oil burner. Efficient combustion over a wide range of capacities with various grades of fuel is attained by a unique design which governs the regulation and also the distribution, velocity and turbulence of the primary and secondary air as it comes into contact with the oil. Ease of regulation, in turn, allows close control of furnace atmosphere; while the efficiency of the burner when handling fuel oil in capacities as low as ⅛ gal. per hour makes it possible to distribute the heat *uniformly* throughout the furnace by burning a small quantity of oil in each of a large number of burners. Oil enters through a small supply line at the back, passes through a central oil tube to a distributor inside the burner housing, where it is directed into an oil chamber surrounding the primary air orifice. Air enters through a butterfly valve in the center lower portion of the burner housing whence part of it enters the distributor head and passes through the primary air orifice and then through a venturi. This creates a partial vacuum in the oil chamber so that oil is withdrawn in a thin film around the air. This film is broken into a fine mist and is intimately mixed with the primary air as it passes through the venturi. The secondary stream of air flows between the burner body and the outside of the venturi mixer. It is given a whirling



action and is then discharged through the orifice near the nose of the burner. Here it acts on the primary mixture to provide further atomization and mixing. Variable capacity is obtained by turning a handwheel at the back of the burner, which causes the venturi to move longitudinally and thus to vary the secondary air opening at the nose of the burner. There are nine sizes of burners in the line, ranging from ¾" to 6" for pressures ranging from 8 oz. to 32 oz. of air and for capacities of ⅛ G.P.H. and upward.

A High Duty, Draw-Cut, Flash Trimming Machine

The Morton Mfg. Co., Muskegon Heights, Mich., has brought out a high duty, draw-cut, flash trimming machine which is especially designed for removing the flash from butt welded steel rings such as automobile wheel rims. It is designed to take a width of seam up to 12 in. and stock thickness from 24 gauge to 3/16 in. Power is applied by an electric motor driving a hydraulic pump. The machine has a variable and return speed from 0 to 65 ft. per min. The power is applied to two reciprocating rams by means of hydraulic operated cylinders. The work is placed between hardened dies



and sufficient pressure is applied through a hydraulic operated spring loaded toggle motion to securely clamp the work while trimming. The company's patented feature of vertically adjustable ram and dies is employed which automatically takes care of the clamping and positioning of the cutters in relation to the work. It automatically compensates for any variation in stock thickness. The upper ram raises 2 in. giving sufficient clearance for entering and removing the work. The cycle of operation is automatic. As the work is entered, the operator steps on the button, the machine automatically clamping starts its cut on the draw-cut stroke, releases the work at the end of the stroke, and the cutting tools return to the out-position. The distance from the clamping die to the floor is 55 in. This may be varied to meet operation requirements. Also, the company's patented adjustable tool holders and tool set-up are employed. This feature assures quick interchangeability of tools, long tool life and maximum production. Exceptionally high production is claimed possible with this new high duty draw-cut flash trimming machine. This machine is described in the company's Bulletin No. 26X.

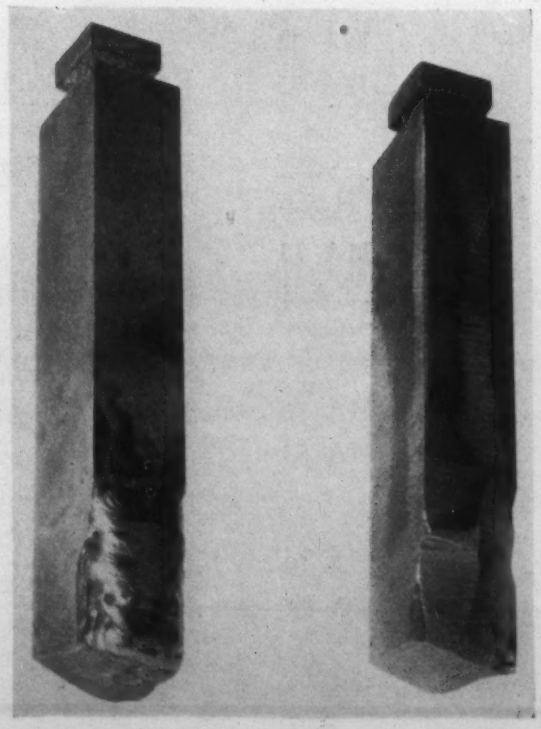
New Synthetic Rubber-Like Product

The remarkable properties of a new material called "Koroseal" continue to astonish the chemists and engineers of The B. F. Goodrich Co., Akron, Ohio, responsible for its discovery and development. At present the prohibitive cost of manufacturing Koroseal precludes its adoption as a general substitute for rubber but some of its characteristics are claimed to render it far superior to rubber for certain specialized applications. Although not the same as rubber in chemical composition it may, like rubber, be varied by compounding methods from very hard to a soft, doughy consistency and can be molded into any shape. Koroseal can be produced, also, in a variety of colors. It is odorless. The resistance of Koroseal to swelling when exposed to many oils and greases and to disintegration in the presence of corrosive chemicals is unusual. Great resistance to moisture and stability over a wide range of temperature make the extremely soft varieties of Koroseal ideal for molding ornamental plaster casts.

Electrode for Hardfacing and Cutting Edges on Tools

A new arc-welding electrode which is designed for restoring worn cutting edges on tools of all kinds and which is said to permit savings of 20 to 25 per cent in tool cost is announced by The Lincoln Electric Company, Cleveland, Ohio.

This new electrode, known as "Toolweld," is the product of several years of research. By using this electrode, lathe tools, bits, milling cutters, drills, cutting and forming dies and all other tools which have become worn in service can be given a new and harder cutting edge than has heretofore been possible. Tools can be refaced an unlimited number of times with this electrode. Also new tools using ordinary steel in place of high-speed steels can be provided with a cutting edge. The new electrode provides a deposit which is equivalent to high-speed tool steel, and has the advantage of retaining its hardness (55 to 65 Rockwell C) under relatively high temperatures, up to approximately 1000 deg. F. The degree of hardness will vary somewhat depending upon the admixture of base metal with the weld deposit. In general, hardness is increased by permitting the deposit to cool slowly and by depositing additional beads. This deposit can be heat treated in the same



manner as high-speed steel but at slightly less temperature. Tests of cutting edges built up with this electrode are said to reveal results which are superior to those obtainable with ordinary tool steel. The "Toolweld" electrode is made in 14-in. lengths in four sizes—3/32 in., ⅛ in., 5/32 in., and 3/16 in. It comes packed in 5-lb. containers. The illustration shows (left) deposit of "Toolweld" electrode on a cutting tool, before grinding, (right) the same tool after severe service in machine tool work.

An Insulating Cement

"Sonittep Insulating Cement" is the result of several years of careful research in the refractories engineering department of George F. Pettinos, Inc., Philadelphia. Many different kinds of insulation and insulating material were tested but not one of them equalled the specifications that the engineers and sales department had set up. In fact, it seemed at times that the specifications would have to be modified.

Some of the points covered by these specifications follow: 1.—The insulating cement must be light in weight, light in color, and easy to apply. One hundred pounds of cement shall cover at least 50 sq. ft. of surface to a thickness of 1 in. 2.—The cement must be shipped in dry form to eliminate needless freight charges and require only mixture with water for application. 3.—The cement must be made to adhere to hot or cold surfaces of practically any texture or material without reinforcement with wire or nails as is the usual practice on other cements. 4.—The cement must be able to stand temperatures up to 2000° F. and must be reclaimable at temperatures up to 1400° F. 5.—The cement shall not crack, loosen or peel off and it shall be resilient to shock and withstand much vibration. 6.—The cement shall require little or no maintenance once it is applied. 7.—The cement shall be such that unskilled labor can apply it. 8.—The cement shall have little or no shrinkage when drying after it has been applied. 9.—The cement must be equal to or better than 85% magnesia in insulation value and have three to four times the insulation value of the ordinary asbestos cement. 10.—The price must be equal to or lower than any other cement to do any specific insulating job. Finally Sonittep insulating cement was perfected by the use of a certain variety of mineral wool being used as a base to which different other ingredients were added as binders.

The next step, after the laboratory work had been completed, was to make several applications of this cement on various types of furnaces, ovens, boilers, etc., to actually prove that the laboratory figures were absolutely correct. Realizing that one of the most severe tests on any plastic insulation cement was the complete insulation of an open-hearth furnace, a 10-ton open-hearth furnace was tried by applying 2 in. of cement over the entire area of checker chambers, end and side walls, as well as the roof. This was applied in four coats, the first being only about ¼ in. thick, allowed to dry before application of the three succeeding coats, the last coat being trowelled to a smooth finish.

The first open-hearth furnace insulated has been in operation for 1½ yrs. and has shown the following results since insulation:

Average fuel saving for the 1½ yr. period is 21%.

The refractory life of the brick is better than when the furnace was uninsulated and there is no sign of the brick spalling.

The saving in fuel paid for the insulating cement and the labor of applying it after only two months of operation.

Since insulating this first open-hearth furnace a number of others, ranging from 10-ton capacity up to and including 100-ton capacity, have been insulated

This new cement has many other uses besides on open-hearth furnaces. Among other practical tests, the successful insulation of the following can be included: Annealing furnaces; reheating furnaces; hardening furnaces; forge furnaces; high and low pressure boilers; core drying ovens; oil, tar and water tanks; large hot water and air pipes; coke oven bulkheads; sodium silicate furnaces and glass melting furnaces.

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